CIVIL ENGINEERING

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GRADE SEPARATION ON WANTAGH PARKWAY, LONG ISLAND, N.Y.; MERRICK ROAD IN FOREGROUND
Existing Streets Used as Access Roads Where Possible

Volume 5 — Number 3 —

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MARCH 1935

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Among Our Writers

MAURICE DEUTSCH, who holds the degree of C.E. from Columbia University, was for five years with the Foundation Company. Since 1911 he has maintained a consulting practice, specializing in structural engineering, foundation work, and residential, office, and factory buildings. He designed, constructed, and operated one of the first open-garden apartments in New York City.

HARRISON P. EDDY, JR., has been associated with Metcalf and Eddy almost since graduation from the Massachusetts Institute of Technology, the last eight years as a partner. He has specialized in refuse disposal problems and has been responsible for the design by his firm of several large incinerators, including those at Washington, D.C.

E. C. HARWOOD graduated from West Point in 1920 and in 1922 received the degree of C.E. from Rensselaer Polytechnic Institute. After several years in the Corps of Engineers, he returned to Rensselaer for additional work in civil engineering and business administration, earning master's degrees in both. For the past four years Lieutenant Harwood has been on the staff of the Massachusetts Institute of Technology.

F. C. SHEPHERD since 1912 has been with the Boston and Main Railroad, as engineer of construction, valuation engineer, assistant chief engineer, chief engineer of construction, and since 1927, as consulting engineer. For the first 15 years of this service he was in charge of all construction work. Since 1927 he has had charge of public relations concerning construction in which the public had interest.

E. C. LAWTON began his 26 years of public service as an assistant engineer on the New York State Barge Canal. For the past 21 years his connection with the Division of Highways of New York has been continuous: first in the Buffalo District, then as Grade Crossing Engineer at Albany. For the past four years he has had charge of all specifications, design, and construction work in the state.

A. B. BARBER was educated at West Point and served in the Corps of Engineers on military and public works. During the World War he was in charge of transportation and distribution for the American Relief Administration. Colonel Barber resigned from the Army in 1920. Since 1923 he has been with the U. S. Chamber of Commerce.

ROBERT H. FORD had extensive experience in highway-railway grade separation work and related problems in various parts of the United States, particularly in New England and in the Central and Southwestern States. As Engineer of Track Elevation for the Rock Island Lines, he was in charge of extensive track elevation projects in and around Chicago.

JOSEPH J. DARCY since 1910 has held various engineering positions with the Departments of State Engineers—Public Service and Public Works of New York State, with the exception of two years in the 303d Engineers with the A.E.F.

RICHARD H. GOULD spent 1½ years in Germany on sewage disposal work under Dr. Imhoff. For the next 16 years he was engaged in consulting work, chiefly under the late James H. Fuertes. He entered the employ of the City of New York as chief engineer of the Wards Island Sewage Treatment Works at the inception of this project in 1928.

HARRISON G. ROBY, soon after graduating from the Thayer School of Civil Engineering in 1906, became resident engineer on hydro-electric construction in Michigan. During the War he served as Lieutenant Commander in the Civil Engineering Corps of the Navy. Since 1922 he has been with the Byllesby Corporation, from which firm he has been on leave since 1933 to act as consultant to the U. S. Corps of Engineers.

RUSSELL VAN NEST BLACK, after graduating from Cornell University, began his planning work in the office of John Nolen, of Cambridge. He has served as chief planning engineer for the Philadelphia Regional Planning Federation and, since 1929, has been in private practice. He is a frequent contributor to the technical press.

FREDERICK H. MCDONALD was instrumental in forming the Engineering-Economics and Finance Division of the Society, of which he is secretary. He was secretary of the Georgia Section of the Society for three years, and in 1925 its president. He maintains a consulting engineering office in Atlanta.

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CIVIL ENGINEERING

MARCH 1935

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VOLUME 5 NUMBER 3

Slum Clearance Plan for New York

How Government-Aided, Low-Cost Housing Projects Can Restore Blighted Areas in Large Cities

By MAURICE DEUTSCH, ARCHITECT AND ENGINEER, NEW YORK, N.Y.

ALTHOUGH for two years Government funds have been available for the eradication of slums, so far little has been accomplished in that direction. A plan for the rehabilitation of the blighted areas in New York has been developed by Mr. Deutsch, who presented a detailed description of the plan before the City Planning Division on January 17, 1935, during the Annual Meeting. An abstract of this paper is given here. Although prepared for the situation in New York, the plan developed by the author is applicable to any city having similar conditions. He plans four-story, fireproof structures to be built in units, without elevators or extensive basements, providing apartments of from two to six rooms that will rent for an average of from $6 to $6.50 per room per month. The property to be developed lies in six blighted areas of Manhattan and Brooklyn now largely occupied by obsolete, unsanitary, crime-breeding tenements. It is proposed that the occupancy of these low-rental, slum-clearance projects be strictly limited to those who cannot afford higher rent—those whose incomes do not exceed, say, $1,500 per year.

With a 30 per cent Federal grant on the cost of construction, the projects are to be financed by first-mortgage bonds of the Municipal Housing Authority, aggregating two-thirds of the total cost, and the property is to be paid for, at its present assessed value, one-half in cash and one-half in guaranteed annual payments taken from the surplus of the operation of the properties. Experience has shown that utilization of slum areas for such projects will be cheaper, more practical, and more advantageous to the city and the public than construction of similar buildings on vacant property in the suburbs.

GREAT cities like New York face serious credit planning and housing problems. It is no longer necessary to picture in distressing detail the living conditions of a part of the population in our large cities, for it is generally known that about two-thirds of the population in these cities live in substandard and unsanitary buildings, and pay an average rent of less than $6 a month per room.

Records show that there are still over 69,000 substandard buildings in New York alone which, even in 1900, were considered unfit for human habitation. In spite of the great wave of prosperity and the enormous funds spent for the construction of skyscrapers, and of different types of improved business and residential buildings, nothing has been done to provide better housing for those compelled to live in these slum areas. For many years these properties have been in arrears for taxes, and the buildings have violated the tenement house and health laws. It is obvious that if such local laws had been enforced, many of these properties would long ago have been owned by the city and the buildings would have been demolished. The fact that highly assessed land and building values have been permitted in these slums, in spite of the fact that blighted areas are really bankrupt areas, is a commentary on local politics.

Although there is as yet no real demand in the large cities for such new structures as factories, more expensive apartments, offices, and banks, there are 37 major industries in the United States that are dependent upon the building industry for their business. A study completed by the American Construction Council indicates that, exclusive of the cost of mining raw products, over 80 per cent of the cost of any building construction job goes to labor. Except for the rebuilding of blighted areas, there is no possible opportunity at the present time for building construction on any important scale. In spite of the fact that, for over two years, Federal funds have been available for housing developments, and that New York State had the first State Housing Authority as well as a Municipal Housing Authority eligible to receive such funds, scarcely a single, legitimate, slum-clearance project has been started there.

To obtain low rental housing, it is necessary to reduce costs in all directions by eliminating unessential expenses, graft, labor disputes, and selfish exploitation. Years of careful study and detailed research covering proposed slum-clearance projects in five sections of New York, which would involve an expenditure of over $115,000,000, have made clear not only the fact that slum clearance is a necessity, but also that it is feasible. Low rental housing can be provided in the areas in question at rentals that the present tenants can afford to pay. Those who cannot afford to pay any rent must of course be taken care of by private and municipal charities.

The purpose of slum clearance is not to give homes to homeless people. It is designed to eliminate conditions harmful to the health and happiness of the residents of the so-called blighted areas; to benefit the community as a whole by raising the standard of living of the most backward part of the community; and to wipe out an environment largely conducive to the growth of crime and the making of criminals. This means that slum clearance projects first involve the demolition of the old buildings in slum areas. An important con-

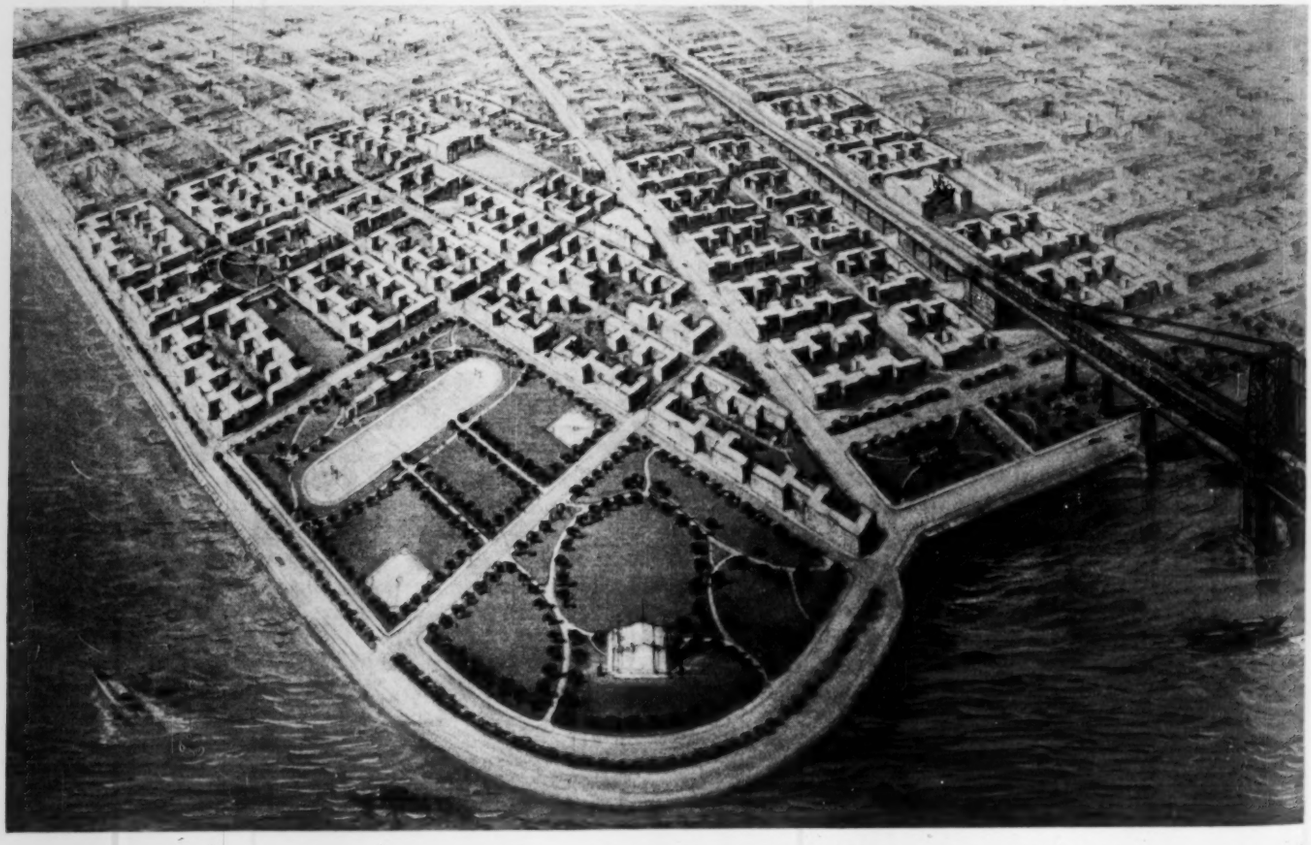
sideration, in so far as a city plan for the general public welfare is concerned, is to prevent the use of an entire blighted area solely for houses in the lowest rental range, or solely for those in a higher range. To avoid repercussions that will seriously affect municipal credit as well as investments in real estate, the start toward slum clearance should be made in a small development simultaneously in each of several blighted areas in a large city.

Cities that have tried to eliminate slum conditions by providing new houses on vacant land in outlying districts have found that, after ten years, there is no improvement in the slum conditions in the old areas, and that the burden to the city at large has been increased by the necessity of providing public utility facilities for the new district. In the large cities, slum areas generally are provided with good transit facilities, and thus are well situated with respect to affording their residents an opportunity to obtain employment nearby. These areas also have the advantage, for low rental housing, of the existence of sewer, water, gas, electric, and other utilities, the production cost of which must be added to the cost of housing developments in outlying vacant land areas. Another advantage of rehabilitating blighted areas lies in the fact that most of the unemployed now live in such sections. By giving employment and housing preference to the residents of the area under development, the whole economic status of the people will be benefited.

Finding a plot on which to commence operations in a blighted area has thus far constituted the most difficult problem in connection with slum clearance. A study of the ownership of property in a typical blighted area, such as the lower East Side in New York, discloses the fact that about 60 per cent of the 2,870 structures analyzed have either no mortgage or a private mortgage. The remainder are mortgaged by savings and other banks, trust companies, and insurance companies, while comparatively few have been foreclosed in recent years. Many of these mortgages have been in existence on the same properties for more than one generation and frequently constitute an amount in excess of the values for which the properties are now assessed by the city. Furthermore, as a general rule, the city has assessed the buildings—practically none of which can be considered as a source of income—for either the same or more than the assessment on the land.

Since the major problem in slum clearance has proved to be that of land assembly, an excess area should be condemned in those locations where the majority of owners have offered to accept the annuity plan of payment for property; that is, half in cash and half in annual payments deriving from the surplus obtained from the operation of the housing project, and at costs not in excess of present assessed values. The project should be designed, constructed, and operated by those in private practice who have satisfied the requirements of experience, honesty, and integrity, and who have a high sense of responsibility for public trusteeship. Such fair and reasonable fees are to be paid as will assure a reasonable profit to those who cooperate. Projects should be supervised by, and built for, the Municipal Housing Authority. Under the present housing law for New York, in cases where rentals are to be maintained at an average of not over $6.50 a room, taxes are to be paid to the city on the present value of the land rather than on its value after improvements have been made.

The Federal Government is to cooperate by providing



BIRD'S-EYE VIEW OF PROPOSED CORLEARS PARK HOUSING DEVELOPMENT ON LOWER EAST SIDE

A Slum Clearance Project to Occupy 128 Acres at New York Approach to Williamsburg Bridge. Development Will Contain 6,000 Apartments, Nursery and Club Buildings, Central Heating, Incinerators, Refrigerators, and Garden and Playground Areas

TABLE I. ESTIMATES OF COST OF PROPOSED SLUM-CLEARANCE PROJECTS

PROJECT	AREA IN ACRES	PROJECT TOTAL COST	FEDERAL GRANT	ASSESSMENT, 1934		FIRST-MORTGAGE BONDS, 66⅔ PER CENT	APTS.	ROOMS
				Land	Building			
Corlears Park, Lower East Side, Manhattan	128*	$ 33,229,000	$ 5,480,000	$ 7,075,000	$ 7,887,000	$22,152,000	6,008	20,800
Franklin Village, Greenpoint, Brooklyn	126*	25,231,000	5,116,000	3,352,000	4,825,000	16,821,000	5,559	19,790
Clinton Village, Red Hook, Brooklyn	58	9,355,000	2,161,000	808,000	1,344,000	6,236,000	2,417	8,200
DeKalb Village, Williamsburg, Brooklyn	48	15,286,000	3,097,000	1,886,000	3,078,000	10,191,000	3,376	11,880
Tompkins Village	82	25,553,000	4,828,000	3,705,000	5,753,000	17,035,000	5,248	18,690
Harlem, 135th to 138th Street and Harlem River, Manhattan	11	6,000,000		(land and buildings) 2,050,000			1,557	5,780
Total		$114,654,000	$20,682,000	$16,826,000	$22,887,000	$72,435,000	24,165	85,140

* Including public park and recreational areas.

a grant amounting to 30 per cent of the cost of construction of the new buildings. It will also attempt to obtain the cooperation of labor unions, in an effort to avoid strikes and to prevent an increase or decrease in the prevailing wages during the period of construction. If private capital is not willing to cooperate after the project is begun, the Government may supply necessary funds for the completion of these projects. The Municipal Housing Authority could act as owner of the project, or the PWA could serve temporarily in this capacity until the city's obligations have been met. In that event, the total interest and amortization need not exceed 5½ per cent, and the design, construction, and operation should be entrusted to competent and experienced persons in private practice, under Federal control. This may include a premium for insuring investments.

If the first development proves a success, less and less financial cooperation from the Government will be necessary. It will then be possible to provide housing developments for the next range of rentals, averaging $9 a room and, after that, for the next, averaging $15 a room. As a result of advances in the art of construction, many buildings now in use will have become more and more obsolete by the time these improvements are completed. This will open new fields for the construction by private enterprise of buildings in the higher rental group.

For low-rental slum-clearance projects, buildings should be fireproof and limited in height to four stories, with maximum facilities for light and air. Best results may be obtained by a unit system of design, limiting each building to one enclosed, fireproof, street-lighted stairway with from two to six apartments to a floor. By limiting the number of apartments on each floor to not over six, or 20 rooms, and the aggregate number of apartments above the first floor to not over thirty, or 100 rooms, exterior fire-escapes may be eliminated in conformity with the New York City Multiple Dwelling Law. Thus long halls and waste space will be avoided.

During the years when immigration was flooding the country with people from foreign lands, there were densities as high as 800 persons per acre on the lower East Side. This has now dropped to around 400 persons per acre. In five-story buildings, this means a very high land coverage.

In order to maintain a low average density for a large area, it is necessary to provide a reasonable amount of park and recreational space. My studies on the subject disclose the fact that the population densities on the lower East Side may be limited to 187 persons per acre for the entire area of the project, while individual blocks with four-story buildings can show a density of 400 persons per acre for block area and yet provide average rentals at $6.50 per month. Similar density studies on six other projects indicate that there is no necessity for the crowding that has resulted in the past.

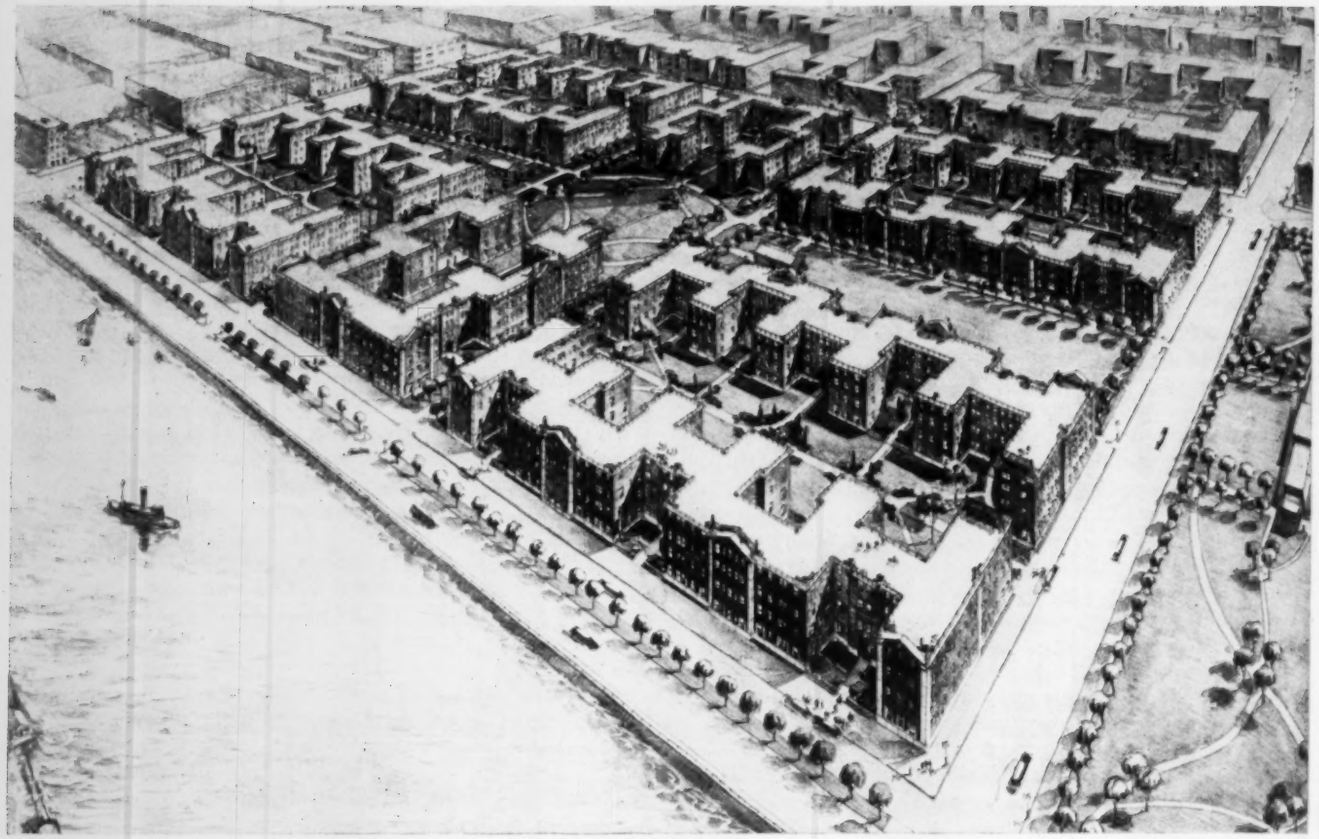
In connection with the operation of the buildings in the lowest rental group under Government direction and financing, the most important consideration is that of control of occupancy. Up to the present time, there has been much criticism of the fact that public funds are used to provide housing at rentals that compete with those of taxpaying property developed with private funds, while tenants from such privately-owned properties, who can afford to pay the higher rentals are permitted to occupy these subsidized buildings. Such a situation must be prevented in the Government-subsidized buildings, where the rentals will average not over $6.50 per room per month. Applicants for admission to these apartments should have a monthly income not in excess of four times the monthly rent to be paid for the apartment. For instance, at the rental of $6 a room per month for a five-room apartment, the maximum limiting income would be about $1,500 per year. Of course some consideration should be given to the size of the family. If the family is large a larger income may be permitted, although it should in no case be more than $2,500 per year.

Preference should be given (1) to disabled war veterans, (2) to families with children, (3) to unemployed persons who are able to pay the low rental, and (4) to person who have been employed during the previous six months and are still employed. Persons with criminal records and those who have damaged public property in such projects should not be allowed to occupy these buildings.

An employment bureau should be established for the benefit of the tenants, so that the management may know when tenants are unemployed and are seeking work. Preference should be given to those living on the premises, for providing painting, carpentry, porter, or any other service required on the premises. Those employed should be paid a fair and reasonable wage.

Each project should contain one or more individual one-story buildings to be used as day nurseries. After 5 p.m., these structures can serve as studies or playrooms for the children of school age. A ramp to the basement of each will provide central storage for baby carriages. It is planned that each of the communities shall contain an administration building, in which are to be located branches of the fire, health, and sanitation departments, clinics, and other important services furnished by the city. Ample park and playground space and community gardens and facilities should be provided in proportion to the number of persons to be housed in the areas.

If the Federal Government and the Municipal Housing Authority cooperate and private capital is permitted an opinion as to the design, building, and operation of such a project, it should be possible to induce savings banks, life insurance companies, and other sources of private capital to purchase the first-mortgage bonds, not in excess of two-thirds of the value of the land and buildings. The Federal grant in such cases generally amounts to about 20 per cent of the entire cost of the project, and the first-mortgage financing to 66⅔ per cent. The cooperation of the owners of the property, by accepting



PROPOSED TYPE OF BUILDINGS AND EXTERIOR ARRANGEMENT FOR SLUM CLEARANCE PROJECTS
Four-Story Buildings of Fireproof Construction. Low Land Coverage

annuity certificates, would take care of an average of about 20 per cent of the entire cost. This would be over 106 per cent of the financing required. Thus, at the completion of the project, there would be a sum available either as a sinking fund or for paying off some of the annuity certificates held by the original land owners.

Either the city or the Federal Government should insure or guarantee the payment of the annuity certificates. Such an insurance plan would be of great psychologic importance in tending to restore the confidence of the public in these important projects. By cooperating with private interests, the Government will obtain the benefit of experience, personnel, and organization not otherwise available, thus avoiding delays and mistakes.

Real estate interests generally and private invested capital would greatly benefit by the construction of such environment-changing projects, because of the fact that they would give private builders the incentive to build large developments immediately adjacent, at higher competitive rentals. All developments in the blighted areas must be controlled by a city plan that will prevent the congestion and the objectionable features that have been the cause of excess depreciation and obsolescence.

Detailed estimates of the cost of the project have been prepared, although there are such uncertain factors in the situation as present labor conditions, the lower margin of profit, and the professional fees. Estimated on a liberal basis, the cost of these four-story, fireproof buildings would vary from $800 to $850 a room, and from 40 to 45 cents per cu ft, including overhead, builders, profit, and architects' fee. These estimates are based upon the use of structural steel with concrete floors, or of reinforced concrete throughout. There are, however, new methods of fireproof construction that ought to reduce the cost to as little as 35 cents per cu ft. Table I gives a summary of the projects studied.

There will be many advantages in such slum clearance developments. The municipality will gain in tax revenues, since taxes are not now readily collectable from the slum areas. It costs three times as much to furnish fire, health, judicial, sanitation, and other city services to these areas as is collected in taxes from them. The construction of the projects will enable the immediate hiring of a number of those who are at present unemployed, especially in the slum areas themselves, and an increase in the buying and rent-paying power of a part of the population will result. After the completion of the initial projects, attractive developments at low rentals will attract numerous white collar workers from suburban sections to adjacent, new, privately developed residential areas nearer their place of employment. This will strengthen the walk-to-work movement and retard the present tendency toward reduction of residential population in certain sections of the city, especially in Manhattan. A general reduction in fire and liability insurance rates may be expected as a result of the fireproof construction and changed environment. Finally, the change in environment in the slum area will be a source of encouragement to those who live there instead of a source of discontent, irritation, and antagonism against society. Such a plan is applicable to any city in which slum conditions need correction.

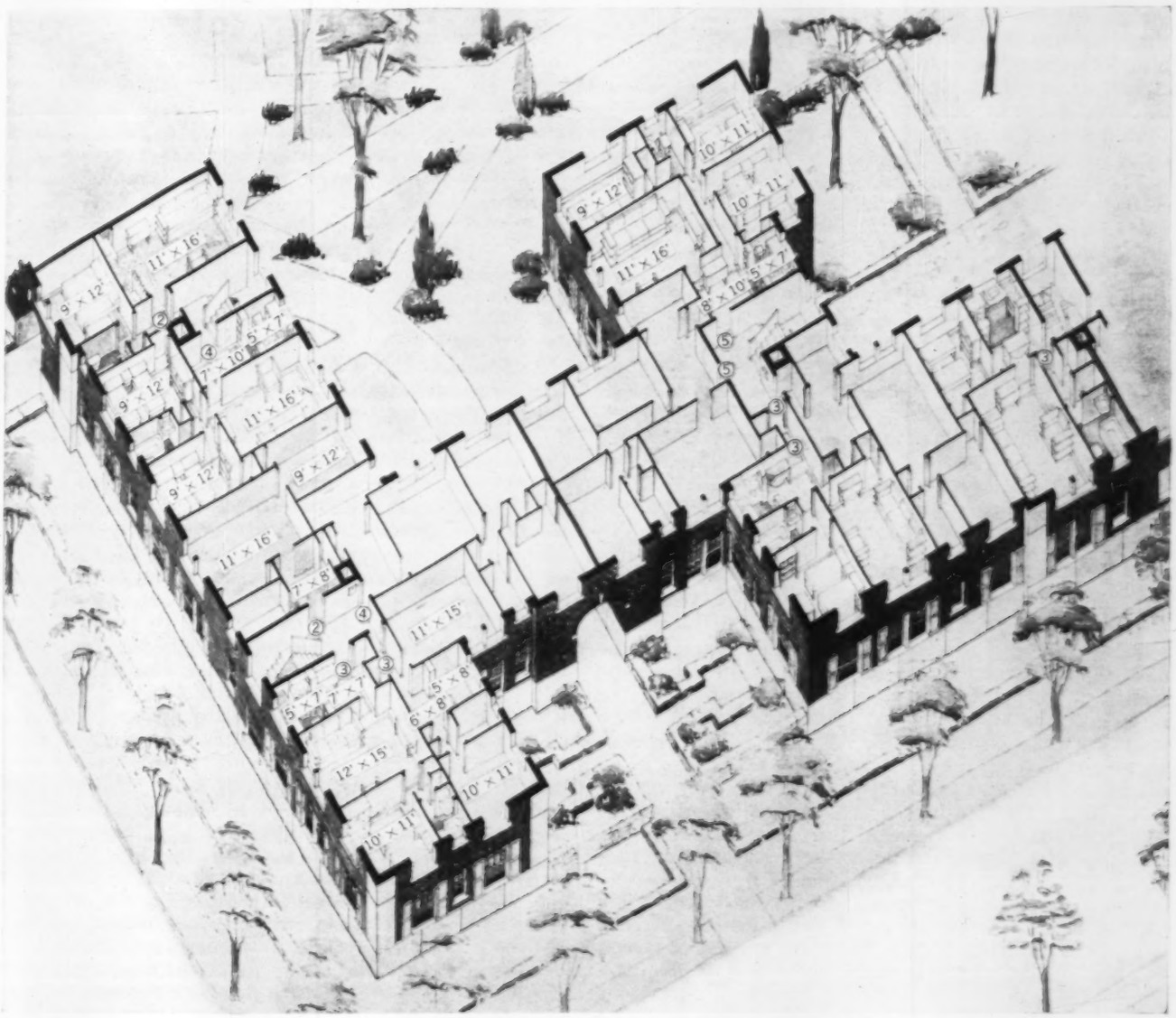
To accomplish extensive, successful, slum-clearance developments under our present form of government, it will be necessary to utilize the funds of savings banks, life insurance companies, and other private investors and to profit by their experience in rebuilding slum areas. Such procedure, however, must be subject to and safe-

guarded by Government supervision. To encourage private investment in these projects, it will be necessary to limit Federal funds to a grant of 30 per cent of the cost of construction, and to impose these further conditions:

1. The first-mortgage investment of private funds and the annuity certificates, or system of part payment to present owners of slum properties, should be insured by a group of private insurance companies of recognized high standing, with the Federal Government providing a Federal reinsurance corporation. Such insured investments would be attractive at lower interest rates, which would make up for the insurance premium. The annuity certificates bear no interest and, if guaranteed, become liquid investments.
2. There should be a system of control with penalties to avoid repercussions seriously affecting other real estate.
3. The cooperation of labor is required to stabilize prevailing wages and avoid strikes during the period of constructing the project.
4. Taxes on land should be at the assessed value before the project is begun.

Under these conditions the projects analyzed in this abstract will not present a financial risk to investors and insurers. The various studies given include the cost of labor at prevailing wages and interest and amortization charges at a total of 5.35 per cent a year, which can include a charge for insurance of the investment of private funds, also the prevailing cost of construction and assessed values for 1934, averaging up to $6 per sq ft. It will be noted from the correctness of these analyses that it will not be necessary to continue delays by forcing interest charges down to nothing, and making the minimum wage of the NRA the maximum.

Whatever policy is ultimately established by the Federal and municipal governments in cooperation, public funds should not be spent for the purpose until it is certain that the project will not affect the ultimate plan and growth of the city. The buildings to be constructed must not be subjected to the danger of becoming slums in turn. Consideration of the various factors affecting the problem of the slum, indicates that slum conditions in a country where modern civilization prevails, is unnecessary. However, such conditions can be permanently eliminated only by the cooperation of private capital, Federal, state, and municipal governments, labor unions, and an enlightened public.



INTERIOR ARRANGEMENT OF ROOMS, APARTMENTS, AND UNITS

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Pretreatment of Sewage for Grease Removal

Modern Methods Include Use of Special Equipment and Adaptation of Standard Facilities

By HARRISON P. EDDY, JR.

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, BOSTON, MASS.

OIL and grease in sewage, often amounting to one-third of the suspended solids present, frequently interfere with the normal operation of a treatment plant or ruin the appearance of bodies of water into which the effluent is discharged. As here explained by Mr. Eddy, two general types of equipment have been developed to remove this high percentage of fatty material. In one the sewage on entering the plant passes through a separate tank—various types are available—in which the grease floats on the surface and is removed by various means. In the second, the grease rises to the top of the sedimentation tank and is skimmed off by mechanical means or collected by water jets. The article was originally presented by Mr. Eddy on January 17, 1935, before the Sanitary Engineering Division during the Society's Annual Meeting in New York.

WITH the large increase in the use of oil during recent years, due to the growing popularity of motor vehicles as well as to the development of oil-burners for domestic and industrial purposes, the occurrence of oil in municipal sewage has presented more of a problem. This is particularly because of garage oils; although the larger garages may catch such material and prevent it from entering the sewerage system, many individual owners discharge waste of this sort into the sewers. Grease also occurs in sewage in large quantities, much of it originating in kitchens, bakeries, laundries, abattoirs, wool-scouring plants, and other industrial establishments.

The quantity of grease and oil in sewage, although always considerable, varies widely in different municipalities. The best available measure of it is afforded by the method of extraction with suitable solvents, which however is not ordinarily used in routine analysis. Results of analyses of sewage from 16 cities, in which the ether-soluble matter was determined, showed an average fat content of 53 ppm, equivalent to about 0.05 lb per capita daily and to 28 per cent of the suspended solids. This is in itself a considerable quantity and is increased greatly by sudden discharges of oily and greasy wastes in relatively large quantities that may not appear in the usual analysis. The quantity apparent to the eye may be increased by the adherence of other matter to the sticky grease.

REASONS FOR REMOVAL OF GREASE AND OIL FROM SEWAGE

Frequently grease and oil in sewage cause trouble in the operation of treatment devices. In fine-screening plants, they tend to clog the screens and increase the cost of maintenance. In other types of treatment plants, fatty substances form unsightly scum on the surface of the sewage in the tanks, and they tend to interfere with aeration in the activated-sludge process. In sedimentation tanks, they interfere with the settling of suspended solids by coating particles of organic matter and causing them to rise to the surface as scum. In some cases it has been found that grease digests with difficulty and causes trouble in the digestion chambers of Imhoff tanks. In the treatment of sewage from residences, estates, and small institutions, grease may rapidly clog subsurface irrigation and filtration systems. At some treatment plants therefore, special provision has been made for the removal of some of the grease and oil from the sewage before it enters the treatment units in which they may cause trouble. In many cases where sewage is discharged into bodies of water that are used for recreational purposes, the removal of grease and oil before discharge is desirable for the prevention of objectionable conditions.

There are two general methods of separating grease and oil from sewage before subjecting it to further treatment: first, by the installation of separate tanks or other devices especially designed to retain grease, oil, and other floating matter; and second, by the collection of such materials as they float on the surface of sedimentation tanks. Equipment which may be installed for the first method includes skimming tanks, skimming-detritus tanks, aerated grease-separating tanks, and grease traps. In certain instances, wool-scouring wastes have been treated separately for the recovery of grease by an acid cracking process, before the wastes were discharged into plants for treatment together with tannery wastes. The Miles acid process has been considered in some cases for municipal sewage.

SPECIAL EQUIPMENT FOR GREASE AND OIL REMOVAL

A skimming tank is a chamber so arranged that floating matter rises to the surface of the sewage and remains there until removed, while the liquid beneath flows out continuously through deep outlets or under partitions, curtain walls, or deep scum boards. The design of skimming tanks to handle municipal sewage has not yet been crystallized. The few American tanks in existence are elliptical or circular in shape and provide for detention periods of from 1 to 15 min. The outlet, which is submerged, is situated opposite the inlet and at a lower elevation, to assist in flotation and to remove any solids that may settle.

Head chambers at inverted siphons are sometimes designed as skimming tanks. That in Washington, D.C., on the two 60-in. siphons under the Anacostia River has been in operation since 1908. It is egg-shaped, about 23 ft long and 16 ft wide, and its inlet and outlet are respectively 6 and 16 ft below the flow line. By means of such skimming tanks much material such as corks and bits of wood, as well as grease and oil, may be removed.

At Akron, Ohio, separation of the heavy, readily settled solids and of the light, floating materials is effected in a single unit called a skimming-detritus tank. Floating wooden booms skim the grease from the surface of the tank and collect it in front of an adjustable weir, over which it is pushed on to a draining bed. Revolving plows move the grit and other solids settling from the sewage to a central hopper, whence they are pumped with about 20 per cent of the average sewage flow to grit chambers equipped with scraper plows.

Here the real separation of grit takes place. After passing fine screens, this "underflow" discharges into the main conduit of the plant and joins the main body of sewage that has passed directly through the skimming-detritus tanks. At Akron there are two tanks, 55 ft in diameter and 12 ft in maximum depth, which provide an average detention period of 12.6 min. The plants at Allentown, Pa., and Dayton, Ohio, have skimming-detritus tanks of a similar type.

Separation of grease and oil from sewage may be facilitated by a short period of aeration. This action may be due in part to the de-emulsifying of the oil, thus separating it from the sewage, and in part to physical action, as the grease adheres to the small air bubbles and is carried to the surface with them.

Several systems have been developed for the removal of grease and oil by aeration. Imhoff has built combined aerating and skimming tanks at several plants in the Ruhr District, in Germany. This type of tank is rectangular in plan and has a trough-shaped bottom. A detention period of about 3 min is employed. The tank is divided into three compartments by longitudinal vertical baffles, and the central section is aerated through porous plates set in the bottom. The scum collects on each side of the aerated section and is removed. Tanks of this type have been installed at Springfield, Ill., and Pasadena, Calif.

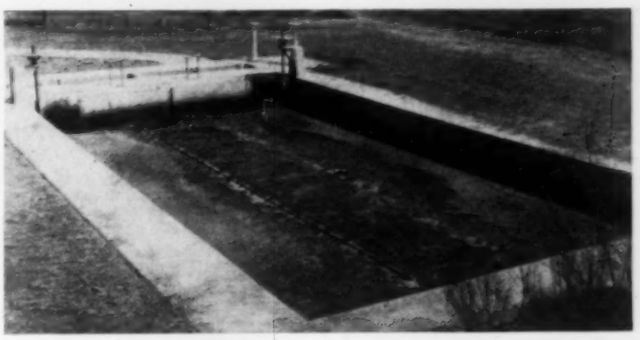
At Whittier, Calif., there is a pre-aerating chamber, 40 ft long, 10 ft wide, and 9 ft deep, set in front of a skimming chamber 10 ft square, in which the scum is collected in a trough while the effluent is drawn off at the bottom. The aeration system is of the ridge-and-furrow type.

Recently tanks or channels have been used at some plants to provide a short period of aeration preceding treatment in sedimentation tanks equipped with skimming devices. After the sewage has been subjected to aeration for a short period of time, the grease, oil, and other floating matter are collected and removed by skimming devices operated by the sludge-removal mechanisms within the sedimentation tanks.

For many years treatment plants for residential and institutional sewage have been protected by traps to catch the grease and soap from kitchen and laundry wastes. The method is to pass the sewage through a reservoir of sufficient capacity to reduce its temperature. Cooling of the hot wastes causes the grease to separate and float on the surface, whence it may be removed by skimming. During the World War, many grease traps at army camps were constructed with capacities of approximately $^2/_3$ gal per capita. The special features of these traps were the relatively large area for the collection of grease, the steep-sided, pyramidal, or conical bottom, and the small diameter of the eduction pipe, which removed the settleable solids. The practice at the army camps was to clean each trap once a week or every other week.

REMOVAL OF GREASE FROM SEDIMENTATION TANKS

In treatment plants that do not have special units for the collection of floating matter, as well as in those where pre-aeration units are provided for grease separation but not collection, oil and grease commonly are skimmed from the sewage in sedimentation tanks. In installations equipped with mechanical apparatus for removing the sludge from such tanks, this apparatus or an attachment to it may also be used to remove scum. In sedimentation tanks equipped with scraper-conveyor mechanisms, which consist of a series of scrapers attached to endless chains, skimming can be effected by so placing the scrapers that the return flight will come at the surface of the sewage in such manner as to accumulate the scum at one end of the tank. Another device adapted to the removal of floating matter is the Mieder mechanism, which consists of a traveling bridge carried on rails along the longitudinal walls of the tank, with a scraper attached to the bridge by hinged arms. The scraper is used to force the sludge into hoppers at the influent end of the tank and, when raised to the surface of the sewage, it is used to skim the tank.



AERATED SKIMMING TANK AT SPRINGFIELD, ILL.

In tanks where the sludge-removal mechanism cannot be readily adapted for use in skimming, a system of water piping with small nozzles, as utilized by H. B. Allen in the Imhoff tanks at Fitchburg, Mass., may be of value. The nozzles, which are horizontal hack-saw cuts in vertical pipes, discharge jets of water almost horizontally over the surface and drive the accumulated grease and oil to points where it can be collected. An installation of this type in the preliminary sedimentation tanks of the North Toronto plant in Toronto, Ontario, has given good results.

Sometimes the grease and oil collected on the surface of sedimentation tanks are removed by hand. They may be dipped up by dippers or drawn off by lowering inverted sluice gates; or they may be drawn into troughs or bays by squeegees.

Grease and oil removed from sewage are commonly disposed of by burial, incineration, or digestion with other sewage solids. If they are to be burned, preliminary draining has been found advantageous. The disposal by digestion with the other solids removed from sewage apparently has been successful at some plants but is reported objectionable at others. In some places the oil skimmed from sewage has been used on roads.

EFFECTIVENESS OF PRELIMINARY TREATMENT

Unfortunately, there appear to be few satisfactory records of the quantity of grease and oil removed by these preliminary treatment processes. Such records as are available indicate that the amount removed, in percentage of total ether-soluble matter in the raw sewage, is small. Nevertheless, the part so removed is capable of floating on water, and if not taken out it might cause objectionable conditions in the bodies of water into which the sewage is discharged and along their banks and beaches. Of course much grease settles with the sewage solids and is deposited as sludge.

The purpose of aeration is to shorten the time required for grease to rise to the surface and thus to hasten the process of removal. Units for removal are valuable in preventing large accidental or occasional discharges of oil from passing to other treatment works and into water courses.

Proposed Improvement of the Cape Cod Canal

Abstract of Paper Presented on January 16, 1935, Before the Waterways Division During the Society's Annual Meeting in New York

By E. C. HARWOOD

FIRST LIEUTENANT, CORPS OF ENGINEERS, U. S. ARMY

CAPE Cod Canal crosses the neck of Cape Cod, which projects from southeastern Massachusetts. It is approximately 50 miles south of Boston, and it connects Cape Cod Bay on the east with Buzzards Bay on the West. The accompanying map, Fig. 1, shows the general location of the canal and the ocean routes from which the shipping through it is drawn.

American commerce had its beginnings in the vicinity of the present canal. It was there that the old Dutch Trading Post was established soon after the Pilgrims settled at Plymouth. History records that Miles Standish there met the traders from New Amsterdam and that frequent meetings between the traders of the two settlements took place in the locality for the purpose of bartering their products.

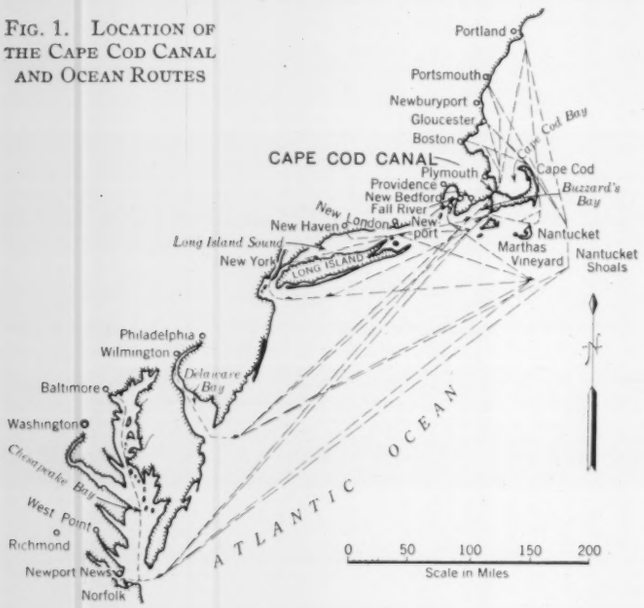


FIG. 1. LOCATION OF THE CAPE COD CANAL AND OCEAN ROUTES

The possibility of constructing a canal was realized at least as early as 1697, and at successive intervals the project was brought into the limelight as one company after another was organized for the work. Few of them got beyond the discussion stage, however, and it was not until 1909 that sufficient financial backing was found to ensure the project's development. At that time, August Belmont and his associates began the undertaking and by 1914 had carried it through to completion.

During the World War, the operation of the canal was taken over by the United States, but when the attempt was made to return the canal to its owners, opposition was encountered. They refused to accept its return on the conditions offered, instead proposing that the Government buy it. After several years of litigation, Congress finally authorized its purchase. Before it was turned over to the Government, it was dredged to a bottom width of 100 ft and a depth of 25 ft.

Including its approach channel in Buzzards Bay, the canal is slightly more than 13 miles long. When the widening now in progress is completed, it will have a minimum width throughout of 205 ft, with the exception of short lengths at the sites of the old bridges. The controlling depth is now about 22 ft.

Funds have recently been available for further widening of the canal at the bends, and two cuts, of 70 ft and 35 ft, have been made. The latter will be completed about May 31, 1935. This has resulted in attracting more shipping, with the result that commerce in 1933 totaled 2,800,000 cargo tons in 11,000 vessels, an all-time high record.

WHY IMPROVE THE CANAL

There are two principal reasons for improving the canal. In the first place, the hazards of the outside route around Cape Cod are great, as is shown by the annual average loss due to wrecks, amounting to $500,000, and deaths averaging 15 per year. The outside route is exposed to the severe northeast storms characteristic of this region; there are no adequate harbors of refuge; and dangerous shoals make a zigzag course necessary. Moreover, currents, ice, and fog make it difficult to follow the course. On the outside route, ice and fog are more frequent and last longer than along the canal.

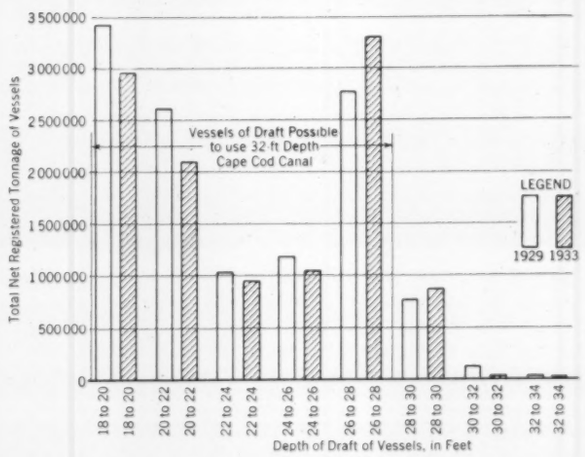


FIG. 2. DRAFTS AND CAPACITIES OF VESSELS ENTERING AND LEAVING BOSTON HARBOR

Secondly, three or four ships go around the cape for every one that uses the canal. Adequate improvement would make it possible for practically all this shipping to follow the inside route. It is estimated that each ship would save at least 65 miles in distance and that the annual interest charges on the improvements contemplated would not exceed 0.2 cent per ton mile for the cargo involved.

HOW IMPROVE THE CANAL

Because of the currents that exist in an open canal, it is generally agreed that the width must be sufficient to

eliminate the hazard of grounding, with the bow on one bank and the stern on the other, during a falling tide, or locks must be constructed to still the waters. However, locks are undesirable from the point of view of most shippers because of the delay involved. Furthermore, recent experience with ice indicates that a lock canal would be frozen over for protracted periods during the winter months when most needed.

A width of 500 ft is desirable to avoid the hazard just mentioned, and a depth of 32 ft is needed to accommodate the bulk of the shipping. From the chart, Fig. 2, showing drafts of vessels entering and leaving Boston Harbor, it is apparent that, considering the 4-ft allowance for minus tides, squat (the tendency of a vessel to drop at the stern when passing through a channel of limited depth), and the possibility of boulders in the canal, a depth of 32 ft is adequate for most of the traffic that presumably will patronize the route.

Estimates indicate that a lock canal with twin locks 250 ft wide and 32 ft deep, would cost $27,499,000; whereas an open canal of the same depth and twice the width would cost $23,172,000. The latter sum is based on the assumption that excavation would be done in the dry as much as practicable. Because of the numerous boulders found in the vicinity, dipper dredges have to be used for most of the land cut, except where excavation in the dry is practicable. Low-cost dredging by hydraulic methods is out of the question for the most part, and the use of shovels, drag-lines, and trucks seems to be the next cheapest means available. Mooring basins at either end are needed for the barges waiting to be towed through and for other shipping which may find it necessary to wait before venturing out into Cape Cod Bay.

TECHNICAL ASPECTS OF THE PROBLEM

Two highway bridges and one railroad bridge are being constructed to replace existing structures, which are of inadequate length for the wider canal. By February 1, 1935, the new bridges were well along toward completion. The highway bridges are similar, each having a 40-ft roadway in addition to the sidewalk. They will provide a vertical clearance above mean high water of 135 ft and a horizontal clearance of 500 ft. When completed, the railroad bridge at the west end of the canal will have the longest lift span in the world, 544 ft between end bearings. In the raised position this Buzzards Bay Bridge will provide a vertical clearance of 135 ft.

When the canal was first built, the original contractors expected to excavate by hydraulic methods. However, that was found to be impossible, except for a short distance at the eastern end, because of the numerous boulders encountered. It was finally necessary to resort to dipper dredges and dry excavation where practicable.

Excavation which it is planned to do in the dry will extend as far below high water as is found advisable. Tests of the perviousness of the soil have been made, and it is believed that this excavation can be carried deep enough to place all riprap in the dry. This will ensure proper placing of the crushed stone blanket under the one-man stone. To place this blanket properly in the wet would be difficult if not impossible.

Early in 1936 the new bridges will be completed, but it will not be possible to widen the land cut further until the old bridges are removed. Earlier widening would leave relatively very narrow stretches near the old structures, with consequent concentration of slope at those points and dangerously fast currents. However, excavation in the dry, placing of riprap, and dredging on the new, more direct alignment for the approach channel in Buzzards Bay, can be carried on in the meantime. The entire program of construction, which will continue over five years at least, involves the removal of approximately 45,000,000 cu yd of material.

OLD RAILWAY BRIDGE AT WEST END OF CAPE COD CANAL
Piers for New Buzzards Bay Railway Bridge Under Construction in Foreground

COMPLEX HYDRAULIC PROBLEMS

Conditions in the Cape Cod Canal present a most difficult problem in hydraulics so far as attempts to ascertain in advance the currents to be expected are concerned. The tides at the two ends of the canal differ in three important respects: mean tide level, range, and timing. Early investigators assumed that the mean tide levels in the two bays were the same, but it is now known that such is not the case. This is fortunate, however, inasmuch as the resulting currents are less under these circumstances, considering that the range and timing differ as they do at present. High tide in Buzzards Bay precedes high tide in Cape Cod Bay by approximately 3 hr. The latter has a range of about 9 ft, whereas the former varies but 4 ft. The difference in level at the two ends of the canal results in alternating currents, which reverse every 6 hr.

Currents and tidal conditions in the canal have been carefully observed, both when it was 100 ft wide throughout and again in 1934, after the widening to 170 ft had been nearly completed. By the application of recently deduced formulas covering the flow of water in open channels, including the condition when flow is against the ground slope, the velocities to be expected were computed. The maximum to be anticipated was found to be about 10 ft per sec, or 6 knots. Somewhat higher velocities have occurred at the narrow sections during the recent widening program without interfering with navigation.

When completed, the Cape Cod Canal will be the widest artificial waterway of its kind in the world. The great bridges will constitute a graceful and inspiring tribute to engineering genius, and the shipping passing through will constitute an important part of the nation's water-borne commerce.

Marine Borers Active on New England Coast

Brief Abstract of Paper Presented Before Waterways Division on January 16, 1935

By F. C. SHEPHERD

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, BOSTON AND MAIN RAILROAD, BOSTON, MASS.

AT the present time the coastal waters of New England are showing an extraordinary increase in marine wood-destroying organisms. Serious destruction is evidently going on where there is any timber construction in such waters. For this reason a committee, of which I am chairman, has been organized by the New England Railroads, the Commonwealth of Massachusetts through its Department of Public Works, and the State of New Hampshire through its Highway Department. The purpose of the committee is to ascertain the extent to which destruction by marine wood-destroying organisms has progressed and if possible to determine the reason for the sudden appearance of the organisms responsible. The committee was very fortunate in obtaining the services of Dr. William F. Clapp as biologist, especially because of his work in the investigations made by the National Research Council in 1922 and 1923.

PROCEDURE BEING FOLLOWED

The first step taken was to place test boards along the New England Coast. As portrayed in Fig. 1, these boards are suspended vertically with their bottoms 2 ft above the mud. They are numbered and removed serially by months. The control block is removed each month. For each block removed a new one is substituted, and that removed is subjected to a careful biological examination. At the present time there are some 78 of these in place from New York, N.Y., to Eastport, Me., most of them located where there are marine structures belonging to the parties interested in the investigation.

Many of these boards have been in for over eight months so that there is now a fairly comprehensive record of action during this period by the wood-destroying organisms. It is planned to carry on the work during 1935. Requests have been received from other public and private bodies to cooperate in the investigation and have boards placed.

Results obtained from many of these test blocks have been astounding. They clearly show that serious destruction is going on both by teredo and limnoria at many places, although local conditions vary greatly. In general the attack is from one or the other of these borers, but there are places where both have been found in the same block. While they are generally present everywhere, the most severe attack by teredo was found to be in Narragansett and Buzzards bays, along Cape Cod, in Cape Cod Bay, and in Plymouth Harbor. On the other hand, the most severe attack from limnoria seems to be centered in Boston and Portland harbors.

Many marine construction companies have furnished the committee with samples of piling or timbers removed from structures on which repair or reconstruction work was going on. A questionnaire sent to many parties owning wharves or other marine structures has revealed destruction in many other places along the New England coast.

At the committee's suggestion, three test boards were installed at the Army base in South Boston late in June 1934. The first few blocks removed showed a very heavy attack from limnoria, which is still progressing. Blocks removed in November were found to be badly damaged by this organism; half of the original outside surfaces had crumbled so that many small pieces of wood adhered to the paper in which the block was wrapped. The control blocks showed many limnoria. As the result of an examination made last year and the block records for this year, the Federal authorities have finally decided that some decisive steps are necessary to prevent further damage. An allotment of nearly a million dollars has been made to enclose the pile area with interlocking steel sheet piling and to fill the interior around the wooden piling so as to prevent further destruction.

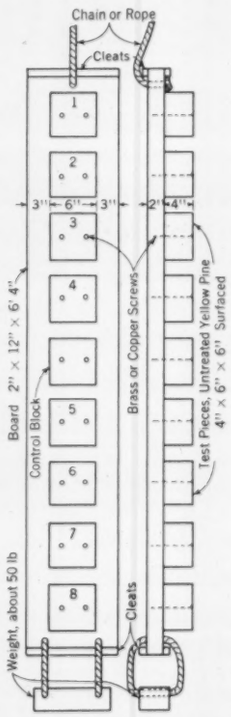


FIG. 1. TEST BOARD FOR INVESTIGATION OF MARINE BORERS

CAUSE OF SUDDEN INCREASE UNKNOWN

Just what is the cause of this sudden increase in teredo and limnoria has not been determined. The committe is not convinced that it comes from any marked change in the condition of the salt water, the temperature, salinity, pollution, or free oxygen content, although further study may prove otherwise. Nevertheless it is evident that at the present time there is not only a marked increase in these organisms but also a heavy migration northward of dozens of types of invertebrates found in southern waters.

A study of the organisms commonly found associated with marine borers may be of the greatest importance in predicting the presence or absence of the latter, since these associated organisms require similar conditions for survival. Where they are known to flourish it may be expected that teredo and limnoria either are present or will thrive if introduced. Hence, in the biological examinations of the test blocks, careful attention is being paid to all organisms present, and a careful record of them is kept. Future studies may disclose an answer.

PROCEDURE SUGGESTED AS RESULT OF STUDY

The committee suggests that where timber structures are to be maintained or new ones built, no timber be placed in salt water unless properly treated with creosote in accordance with the recommended practice of the American Wood-Preservers' Association and the American Engineering Association.

Increasing the Safety of Highways

The Engineer's Part in Designing, Constructing, and Maintaining the Road System and Regulating Traffic

SINCE so many people depend for their safety on the work of the highway designer, only well trained and highly competent engineers should be entrusted with such work. That a closer study of highway design will result in a reduction of traffic accidents is generally admitted. Four authors presented their views on this subject before the joint meeting of the Construction and Highway Divisions on January 16, 1935, during the Annual Meeting of the Society in New York. Their papers are here abstracted.

In treating the basic principles of safe highway design Mr. Lawton discusses the importance of adequate sight distances and the use and misuse of three-lane highways and built-in traffic control. According to Mr. Ford, in the United States there are now at least 30,000 crossings at grade with railroads at which traffic should be separated. As the resulting benefits of elimination largely accrue to the general public and not to the railroads, the burden of their cost should be borne by the public, and there should be a Government subsidy to cover the cost of these separations and Government supervision of the work. Drawing on a lifetime of experience and observation, Mr. Darcy points out many features of design which make highways safer. He advocates the creation of a super-research organization for the group study of all problems relating to highway construction and operation and the dissemination of conclusions. Treating the subject of uniformity in traffic regulations and ordinances, Mr. Barber states that about half of those now in force in the United States are reasonably uniform. In the past ten years 35 states have adopted parts of the Uniform Vehicle Code; the better accident records following adoption of the system provided by the code attest its advantages.

Design Principles and Travel Speeds

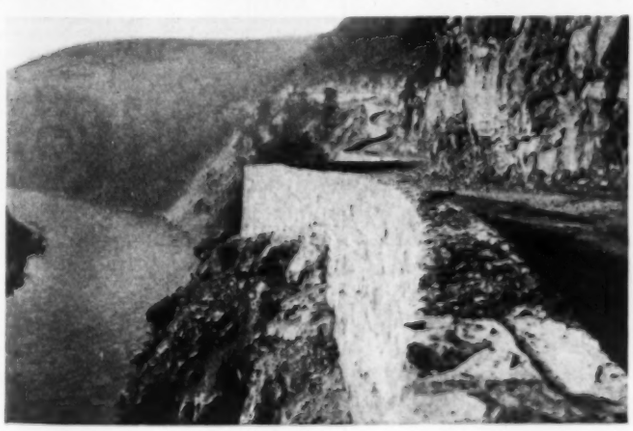
By E. C. LAWTON

ASSISTANT COMMISSIONER OF CONSTRUCTION, DIVISION OF HIGHWAYS, NEW YORK STATE DEPARTMENT OF PUBLIC WORKS, ALBANY, N.Y.

RECENT statistics on accidents occurring on highways indicate that approximately 5 per cent of them may be attributed to highway design. Small as this percentage is, every effort must be made to reduce it and to obtain maximum safety at minimum expense. Unquestionably within the past ten years traffic speeds have affected highway design. The most important factors in relation to safe design and safe operation may be listed as sight distance; alignment, including super-elevation of curves; grades; and traffic control.

IMPORTANCE OF SIGHT DISTANCE AS A SAFETY FACTOR

Sight distance is the maximum unobstructed interval of space in which motorists traveling in opposite directions are visible to each other by day or night. Examples of limited sight distances are given in Fig. 1. Of two highways carrying the same traffic, the one which has the most uniform maximum sight distance is invariably the safest and most free from accidents. To determine what the sight distance should be, it is necessary to begin with certain premises:



HAWKS NEST ROUTE PARALLEL TO THE DELAWARE RIVER
Under Construction Between Port Jervis and Mongaup, N.Y.

1. The highway involved is a two-lane pavement.
2. City or village speed limits do not apply.
3. The maximum speed of any user is restricted to 60 miles per hr.
4. A vehicle traveling at a speed of 45 miles per hr may be passed by another proceeding in the same direction.
5. The passing vehicle starts 60 ft behind the vehicle to be passed and returns completely within its own lane 100 ft ahead of the passed vehicle and also, for both comfort and safety, at least 200 ft away from a vehicle approaching in the opposite direction.
6. Only one vehicle is passed at a time.
7. The assumed speed is uniform until the operation of passing is completed.

Although these premises may be open to debate, they are justified from past experience. A tabulation based on them may be easily prepared, assuming different rates of speed, and the necessary sight distances corresponding to the different assumptions made, may be determined. Two general limiting conditions will be cited:

1. If a vehicle (No. 1) is proceeding at a speed of 48 miles per hr behind a second vehicle (No. 2), proceeding in the same direction at a speed of 20 miles per hr, while another vehicle (No. 3) is approaching in the opposite direction at a speed of 20 miles per hr, the total time required for No. 1 to pass No. 2 will be 4.63 sec and the required sight distance will be about 660 ft.

2. If a vehicle (No. 1) is proceeding at a speed of 48 miles per hr behind another vehicle (No. 2), proceeding in the same direction at a speed of 40 miles per hr, while a third (No. 3) is approaching in the opposite direction at a speed of 40 miles per hr, a time interval of 14 sec and a sight distance of 2,006 ft will be required for No. 1 to pass No. 2.

In Case 2, there is a difference in speed of only 8 miles per hr between the vehicle passing and that being passed.

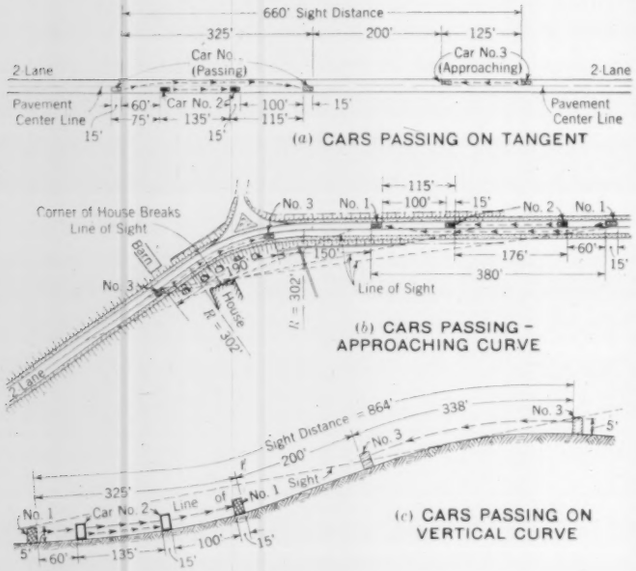


FIG. 1. SIGHT DISTANCES REQUIRED FOR CARS PASSING AT VARIOUS SPEEDS

(a) Passing on Tangent at the Following Assumed Speeds: Car 1, 48 Mph; Car 2, 20 Mph; Car 3, 20 Mph. Sight Distance Required, 660 Ft for 200-Ft Clearance.

(b) Passing While Approaching a Curve in Alignment at the Following Assumed Speeds: Car 1, 40 Mph; Car 2, 20 Mph; Car 3, 20 Mph. Sight Distance Required for 200-Ft Clearance, 770 Ft. If Cars Should Pass at Speeds Indicated, Clearance Would Be Unsafe—Only 150 Ft.

(c) Passing on Vertical Curve, with Assumed Speeds as Follows: Car 1, 48 Mph; Car 2, 20 Mph; Car 3, 50 Mph. Sight Distance Required Is 864 Ft.

With the present trend toward high speeds for both private automobiles and trucks, the eight-mile difference in rate of speed is a common occurrence on highways outside of cities and villages. Under the conditions noted in Case 2, it is evident that only $2^1/_2$ operations of passing, theoretically involving $7^1/_2$ vehicles, could occupy a given mile of highway at any one time. Of course, from a practical point of view it seldom happens that three identical operations are under way at the same moment on any one mile of public highway. On the other hand, it will be clearly evident that where there are many operations involving the passing of vehicles on any given mile of two-lane pavement, the safe capacity of the roadway is indeed limited.

RULES FOR SIGHT DISTANCES

The Department has established the following rules, which govern the provision of sight distances in highway design:

1. On primary routes a minimum sight distance of 800 ft, preferably 1,000 ft, shall be obtained on three-lane pavements, or the three lanes shall be widened to four lanes over summits where it is not economically feasible to make heavy cuts or deep fills, which increase the cost of construction and the damage to property. If four lanes are constructed, a minimum sight distance of 400 ft is to be obtained. These limits are intended as a minimum, with the understanding that a greater sight distance will be secured wherever practicable.

2. On highways now being constructed with two lanes, but which eventually will be widened to three, the sight distances in Paragraph 1 are to govern. Any deviation from this practice must be explained in detail in the engineering report which accompanies designs sent to the main office.

3. On secondary routes and those parts of the state in mountainous territory, where the limits prescribed in Paragraphs 1 and 2 cannot be adhered to, it is expected that a minimum sight distance of 500 ft will be obtained. In this case also the understanding is that greater distances will be provided wherever practicable.

In order to impress upon the designer the importance of obtaining a reasonable and adequate sight distance, it is required that he add under the profile on every road design, a "sight-distance graph" showing both horizontal and vertical sight distances wherever they are less than 1,000 ft. An example is given in Fig. 2. When a motorist comes to a place where the sight distance is suddenly restricted, in a section of road where vision previously has been ample, the travel hazard is increased. Such unfavorable combinations are immediately disclosed by the use of the sight-distance graph. Whenever special conditions unexpectedly reduce the vision at isolated locations, considerable time and money are expended to eliminate or improve them, particularly on main routes. On the other hand, where a number of unfavorable situations rather close together are encountered in mountainous territory, the motorist is prepared by the gradual reduction in vision to operate his car in a safe and rational manner. This feature of gradual reduction in vision is very important in highway design, particularly in rolling and mountainous country where the vision may be restricted for considerable distances. The final choice of a design should be entrusted only to a highway expert. A little knowledge is a dangerous thing, and the novice should not be given responsibility in a matter which so vitally affects the lives of great numbers of people.

WHEN WIDENING IS ADVOCATED

From observations made by the New York State Department of Public Works, it has been concluded that when traffic exceeds 2,500 vehicles in a 12-hr period, a two-lane pavement should be widened or the sight distances increased by reconstruction, or both. A three-lane pavement will comfortably accommodate up to 5,000 vehicles, and if reasonably regulated, up to 7,000 per 12-hr day. These traffic capacities are not based on mathematical calculations, such as computed sight distance, but on observation of traffic over a long period of time, combined with a knowledge of the amount of traffic that various existing routes are carrying satisfactorily. Although the regulation of traffic by police powers will increase traffic capacity to a certain extent, the cost of such regulation and the difficulty of enforcement from a practical point of view should be balanced against, or compared with that for an additional lane of pavement.

Each year since 1922 a traffic census has been taken on practically all the 12,000 miles of improved highway in the New York State system. Usually this is done on the second Saturday in August. With these data, a graphical traffic census map is prepared, showing by variation in the width of the lines the flow of traffic during a 12-hr interval. From a study of these traffic census maps, a master map has been prepared on which

are indicated those highways which should be widened to three or four lanes prior to the year 1940. While it is perfectly logical to say that a two-lane highway which has reached its traffic capacity should be widened to four lanes, it is impossible for financial reason to put in practice such an ambitious procedure. It is also obvious that three lanes will cost less than four lanes and will provide greatly increased traffic capacity for a long period of time before the four-lane pavement would be justified by the traffic density.

By 1940, as this "widening map" indicates, 1,617 miles of the state system should be widened to three lanes and 929 miles to four lanes. When it is considered that there are only 770 miles of three-lane pavement and 229 miles of four-lane pavement in the state, the magnitude of the problem which confronts the Department of Public Works can be realized. And this leaves out of consideration the necessity of obtaining greater sight distances, better alignment, and flatter grades.

Much has been said both for and against the construction of three-lane pavements, but it is felt that they are justified where it is economically impossible to construct four lanes. The principal objection to a three-lane highway is that the middle lane is not for the exclusive use of vehicles passing in either direction, so that a greater sight distance than is considered necessary on two-lane or four-lane pavements must be provided. If the middle lane is properly used, it will greatly expedite the passing of vehicles and increase the traffic capacity of the highway by about 100 per cent over that of two lanes, provided adequate sight distances are allowed in the design. Even for night driving or during rain, snow, fog, and periods of generally restricted vision, when a three-lane pavement probably is not used to its maximum capacity, it gives a larger margin of safety than a two-lane pavement.

ALIGNMENT AND BANKING OF CURVES

Practically speaking, highway alignment in the past has been largely determined by the width of the right of way. In ordinary design there is considerable leeway in choosing the radius of curves. From the standpoint of safety, however, the general principles already discussed should govern, supplemented by an intimate knowledge of curve widening, curve banking, and surrounding topography. A motorist should not be brought unexpectedly to a curve with a short radius in otherwise open country. If possible, it is wise to select a design that does not require the use of signs.

The subject of curve banking and widening, as it affects speed, covers a very large field, particularly from the standpoint of theory. In one case computations were made of the centrifugal force tending to cause skidding and the opposing tractive forces tending to keep the car in its proper lane on the pavement. But the tractive forces used were based on the assumption that the vehicle was proceeding on a dry concrete pavement. This theoretical treatment presupposed conditions that frequently do not exist in the 12,000 miles of

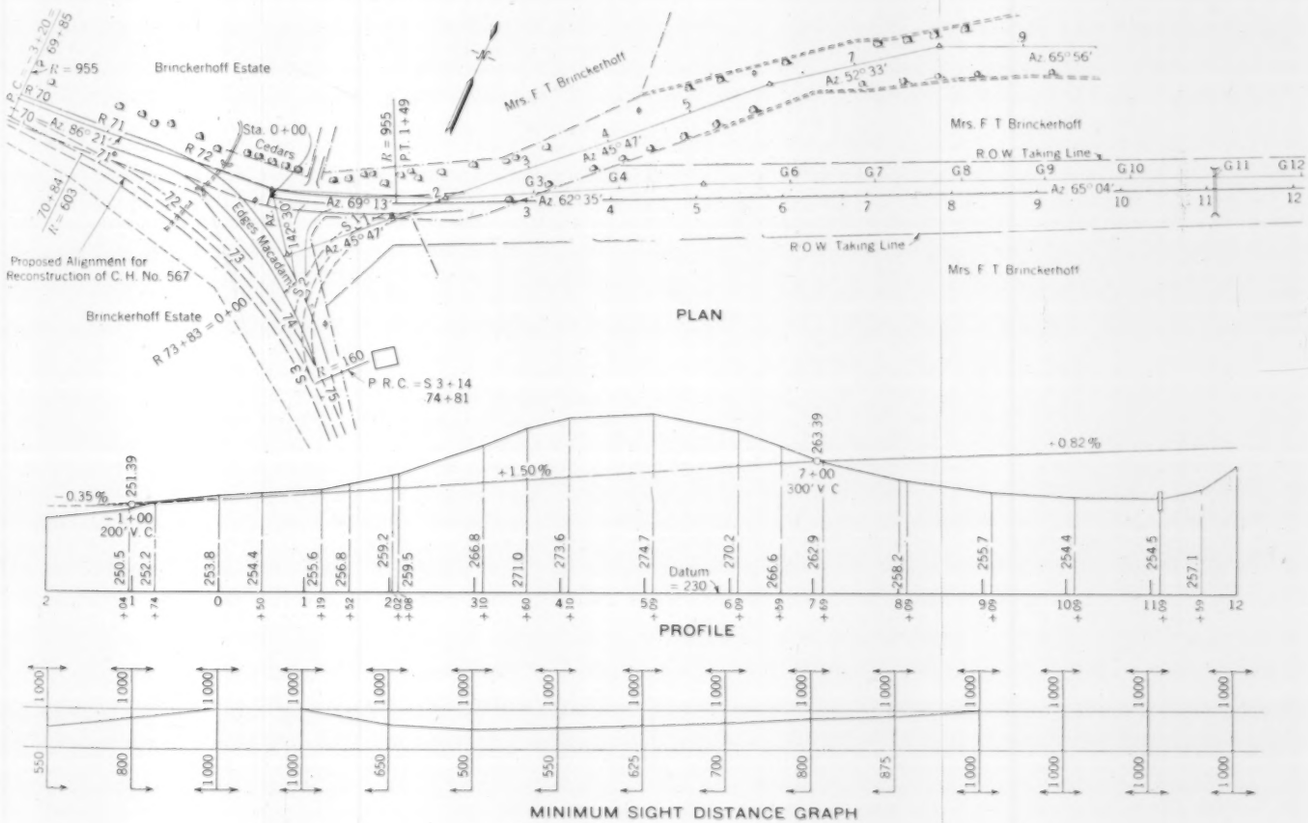


FIG. 2. USE OF SIGHT-DISTANCE GRAPH ON HIGHWAY CONSTRUCTION PLAN

Restricted Sight Distances of Less than 1,000 Ft Due to Vertical Curves, Shown Numerically Above Upper Line of Graph for Each Station, Are Plotted as a Dashed Line. Here No Such Line Appears, Since Sight Distances Are Not Restricted by Vertical Curves. Minimum Sight Distances Due to Horizontal Curves Are Shown Numerically Below Lower Line and Plotted Graphically by Solid Line. Arrows Show Direction of Indicated Restricted Sight Range, Eye and Object Observed Being Assumed at 5 Ft Above Ground. Restricted Sight Distance Is Calculated Independently for Curves and Obstructions in Both Profile and Alignment.

the state highway system. There are various types of pavement, various widths of roadway, and varying climatic conditions which vehicles must encounter during winter and summer, daylight and darkness, rain, fog, sleet, snow, and ice. All these changing conditions must be considered in any attempt to evolve a theory regarding the banking of curves.

The present practice of this department in widening and banking curves represents the consensus of opinion of the highway experts who have long been in its service. Also it has been correlated with the practice of other agencies doing similar work. The theoretically efficient

GRADE SEPARATION ON PEEKSKILL (N.Y.) BY-PASS
Traffic Expedited and Dangerous Intersections Eliminated

banking for summer driving creates undue hazards for winter driving. A slow-moving vehicle on ice or snow will slide toward the inside of the curve and into the pathway of vehicles traveling in the opposite direction, thus materially increasing driving hazards. Present-day practice in the banking of curves varies from $\frac{1}{8}$ in. minimum to $\frac{7}{8}$ in. maximum per foot width of pavement on practically all types of pavement used in the state. Normal pavements are widened around curves of smaller radius. In addition, regular curves are relieved by easement approaches, thereby increasing the effective or traveled radius by nearly 100 per cent.

On primary routes a radius of 2,500 ft with a minimum of 1,500 ft is standard, and on secondary routes that of 1,500 ft with a minimum of 1,000 ft. With each set of contract plans, standard structure sheets are issued on which are shown various rates of banking and the amount of widening for all intermediate curves as affected by grades. Horizontal curves are never located over summits if it is possible to avoid doing so.

Many times the statement has been made that more accidents occur on straight roads or tangents than on curves. However, it must be remembered that there are many more miles of straight road than there are of curved, and any conclusion drawn from this bare statement which calls in question the efficiency of straight alignment is not well founded. For instance, New Jersey has found on the 51-mile state route from Newark to Trenton, its superhighway, that approximately 50 per cent of the accidents occur at intersections and that 45 per cent occur during the hours of darkness. Further, the New Jersey study indicates that 85 per cent of the accidents are due to some improper action of the driver and that defects in the vehicles themselves are a minor factor. The remaining 15 per cent of the accidents is attributed, by inference, to the highway structure.

Grades on highways materially influence travel speeds. With the climatic conditions commonly encountered in New York State, it has been found in general that icy pavements require sanding on grades as low as 5 per cent. Some authorities seem to be of the opinion that sanding should be done on grades as low as 4 per cent; in fact many motorists feel that level grades should be sanded when the road is icy. They are probably right, considering that the transverse crown of the pavement has a slope of approximately $\frac{1}{8}$ in. per ft.

It is our endeavor in New York State to make the maximum grade 5 per cent on primary routes and 7 per cent on secondary routes. A sincere effort is made to obtain the least possible grade consistent with a reasonable expenditure of funds.

TRAFFIC CONTROL VERSUS BUILT-IN CONTROL

Two methods are available to promote safety. One is traffic control, such as signs and signals, and the other is built-in control, such as grade separations, islands, circles, and guide rails. Experience and observation show that improperly designed built-in control, such as grade separations, with clover-leaf access roads, may be fully as hazardous as a grade crossing. Most accidents at grade separation structures occur where exit or entrance ramps intersect the main highway. The motorist's knowledge of the existence of grade separation structures of itself tends to increase driving speeds; hence it is essential that entrances of access roads be so designed as to compel a vehicle to come to an absolute stop before entering the main thoroughfare.

Lack of funds occasionally compels a highway designer to resort to the use of islands, divisional strips, rotary islands or circles, and channelizing islands in lieu of grade separations. Each of these devices actually interjects an obstruction to the normal flow of traffic and thus is objectionable. While these structures may be justified as an expedient, the history of traffic accidents that may be attributed to their use, points strongly to the conclusion that they should be restricted to an absolute minimum.

If traffic circles or similar structures must be used, it is fundamental that the driver be informed in advance of their presence and of the proper course for him to pursue. This means that the islands must be adequately lighted or signed. The use of a flood light or a flashing yellow signal will be found helpful.

A divisional strip is a piece of land of reasonable width between opposing traffic lanes. It cannot be traveled but may be beautified by planting with small shrubs or adapted to pedestrian uses. Such strips should have a sufficient width so that at intersections several vehicles desiring to make a left-hand turn across traffic can occupy a space between the two regular lanes of travel.

The shape of irregular islands should be largely determined by the angles at which the highways intersect. Irregular islands or divisional strips may be more properly described as deflectors of traffic. Warning of approach to islands is essential.

Rotary islands, or traffic circles, require the same features of lighting as do irregular islands or divisional strips but to a greater extent for the reason that they demand an abrupt change of direction. The diameter of the circle should be great enough to permit safe operating speeds and at the same time allow interweaving of traffic between entering routes. Most accidents occur when vehicles enter at too great a speed and collide with other vehicles or with the island itself. Generally this difficulty can be overcome by placing signs a sufficient distance from the entrance warning motorists to reduce their speed.

Channelizing islands are used on New York State

highways to a very limited extent. Their principal function is to reduce the tendency of drivers to wander when they are passing through complicated intersections.

Several methods of traffic control are in use. These generally do not include built-in features. The designer will have to decide in each case whether the traffic control method, by such means as stop-lights, signs, highway marking, or highway lighting may be preferable to the built-in control method, employing grade separations, islands, divisional strips, circles, or channelizing islands. There is no cut-and-dried scientific method of evaluating these different facilities; the judgment of the designer must be his guide. Boulevard stop signs are preferable to a stop-light at points where a third- or fourth-class road intersects a primary route. A stop-light at such a point will cause accidents because it concentrates the flow on the main highway instead of permitting it to continue in a properly distributed manner. These considerations resolve themselves into the question of whether the benefits derived are commensurate with the cost. In general the answer to this problem must be in the nature of a consensus of opinion of the responsible heads in the department. At least they must designate certain limiting features of design which may only be exceeded in rare instances when accompanied by detailed reports.

GUARD AND GUIDE RAILS TO REDUCE HAZARDS

The primary purpose of guard and guide rails is to warn motorists of the existence of curves or hazardous conditions which it is impracticable to overcome. Their second purpose, fully as important as the first, is to prevent a vehicle from leaving the pavement and shoulders of the highway. A rail is placed on embankments usually around the outside of sharp curves and in some instances along the inside of the curve, particularly on fills of considerable height. There are many places where these conditions are encountered throughout the state highway system. Roughly, there are 5,000 or 6,000 miles of guide rail on the 12,000 miles of improved highways now included in the state system.

Guide rail design is in its infancy. Either the guide rail posts or the rail itself, or both, should possess a limited amount of resiliency for greatest effectiveness. The rail should have sufficient strength to prevent vehicles out of control from leaving the highway and encountering more serious obstacles, such as trees, telephone poles, or steep slopes. On the other hand, it should not have so much resiliency as to cause the vehicle to rebound into the lane of opposing traffic. At the present time, the Division of Highways has several standard types of installation. In varying degrees each possesses the elements that are deemed essential. Whenever the cost is comparable with that of a guide rail, embankment slopes should be flattened to 1 on 4 or less.

There is no vocation or profession which requires more practical ability in the application of theory than does highway design. In the case of many types of structures the forces of mechanics and the forces of nature can be so easily determined that the design process is fairly elemental. In other words, with measurable forces, a knowledge of theory, and a knowledge of foundation conditions obtained from borings, the practice of coordinating these two is so well defined that the likelihood of mistakes in judgment is remote. On the other hand, in highway design it is impracticable to take borings every few hundred feet, or even every few thousand feet, to determine the character of the soil as a foundation. Under the most favorable circumstances only a thin ribbon-like surface, possibly 8, 9, or 10 in. thick, can be constructed to withstand all the forces of traffic as well as those of nature, such as heaving due to frost action. There are 12,000 miles of improved highway in the state system upon which at least 2,300,000 registered motorists of the state are free to come and go at will. Each of them, by simply pressing down the accelerator, may attain speeds of sixty to eighty miles an hour at any time and at any place without much restraint or regulation. Under such uncontrollable conditions, every mile of this vast highway system may be fraught with danger due to improper operation of motor vehicles, or to improper grading, alignment, and sight distance. It seems obvious therefore that the highway designer holds the destiny of more men in his hands than a member of any other profession. The design of highways—which seems so simple to the layman—should be entrusted only to men of wide experience and proved ability.

Uniform Traffic Code for Highway Safety

By A. B. BARBER

MANAGER, TRANSPORTATION AND COMMUNICATION DEPARTMENT, U. S. CHAMBER OF COMMERCE, WASHINGTON, D.C.

WHEN the National Conference on Street and Highway Safety was organized in 1924, its field was unexplored. One of its earliest conclusions was that uniformity in traffic laws and regulations is necessary to bring about real improvement in the traffic situation. Highway transport has long since outgrown municipal and state lines. As there never can be sufficient police supervision to observe all traffic, reliance must be placed largely on the individual driver's obedience to traffic regulations. If these are to command his respect, they must be reasonable and they must be uniform.

At its first general meeting, the National Conference on Street and Highway Safety agreed on principles which in its judgment should be incorporated in all traffic laws and regulations. It soon became apparent, however, that a statement of principles did not meet the need of uniformity—that the actual text of the proposed uniform state legislation must be supplied both to make sure that all important matters were covered and to state the principles in such a way as to permit only one interpretation. Therefore the Conference, with the collaboration of the National Conference of Commissioners on Uniform State Laws, produced in 1926 the first edition of the Uniform Vehicle Code.

It was realized at the time that the arts of vehicle and highway construction and traffic control were undergoing rapid development. It was not surprising, therefore, that by 1930 there was need for a review and revision of the code, and this was accomplished. A similar review was completed in 1934.

It is noteworthy that, whereas the 1930 Conference

found it necessary to make extensive revision of important rules of the road, such for example as the rule regarding right of way at intersections, few changes in any of the rules of the road were made by the 1934 Conference. This seems good evidence that this part of the code, in which uniformity is of special importance, has stood the test of experience.

In 1934 the chief change in the rules of the road was in speed restrictions. Here the action was largely a revision of the system of prima facie limits which had been abandoned by the 1930 Conference in favor of a "no speed limit" system. This proved to be unsatisfactory. In addition to restoring the prima facie limits, the 1934 Conference emphasized the fundamental requirement that under no circumstances should drivers exceed a speed safe for all the conditions then existing, and provided further for the marking of highways with special prima facie limits determined by observation and test.

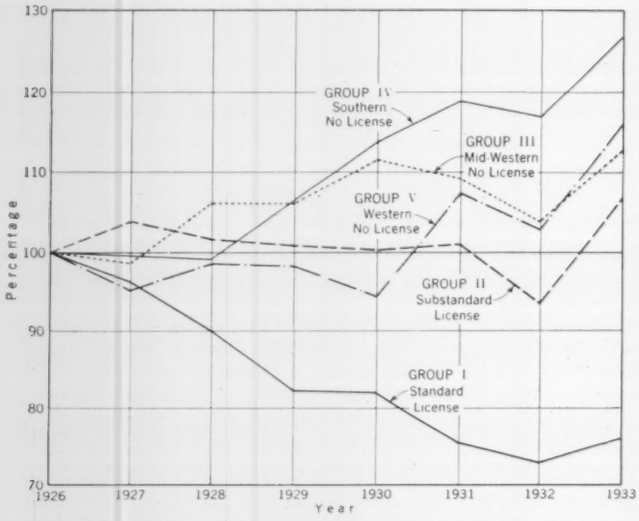


FIG. 1. TRENDS OF MOTOR VEHICLE DEATH RATES IN FIVE GROUPS OF STATES, 1926 BEING TAKEN AS 100 PER CENT
Chart Reprinted from the *National Safety News* for August 1934

Other major changes in the 1934 revision took account of changes in equipment or provided additional safeguards for traffic. The provisions covering head lamps and other vehicle lighting equipment were completely rewritten to accord with the latest advances in such equipment. Provision was made for periodic inspection of vehicles under official control to reduce the danger from unsafe vehicles on the highways. The advantages of compulsory liability insurance, without its evils, were attained by adding a safety responsibility act to the code.

COMPONENT PARTS OF THE UNIFORM VEHICLE CODE

As now revised, the Uniform Vehicle Code consists of five acts, as follows:

Act I. Administration, registration, certificate of title, and anti-theft
Act II. Operators' and chauffeurs' licenses
Act III. Civil liability
Act IV. Safety responsibility
Act V. Regulation of traffic on highways

Act I is a consolidation of former acts covering, respectively, registration of vehicles and certificates of title, or anti-theft measures. The former registration act also included the general set-up for motor vehicle administration, but this was inadequate in some respects, particularly in its lack of enforcement machinery. The new Act I, besides other administrative provisions, includes a measure for state highway patrol such as has proved very effective in a number of states. Another important activity of the traffic department not adequately handled in many of the states, but provided for in this act, is the collection and analysis of accident statistics.

Act II covers the licensing of drivers. The new act is largely the same as the former one, but has been revised in some particulars to meet objections, real or fancied, in states not yet having a license system, without reducing its effectiveness or preventing states more advanced in the administration of such a law from applying whatever methods and tests they may find desirable.

An essential feature of this act is the provision for compulsory examination of all new drivers. A number of states now have a substandard licensing law under which persons having no apparent physical defect or disability are granted licenses on application or after perfunctory examinations given by local officials not subject to any centralized supervision. There is serious question whether such halfway measures do not do more harm than good. The accident records of such states are little if any better than those of states having no form of license system. The principal arguments for such a system are that it may be the entering wedge for a standard license law and that it puts all drivers on record and makes it possible to suspend or revoke their licenses for cause. On the other hand, the existence of an ineffective law often hinders the passage of an effective one. Also if it is worth while to eliminate unsafe drivers by suspension or revocation of license after their inability has been detected, possibly through a serious accident, it is much more sensible to keep them off the roads until they learn the essentials of the traffic regulations and are able to pass a simple driving test.

DIFFERENCE OF OPINION REGARDING LICENSING

Until recently there has been a strange division of sentiment in different parts of the country with respect to the licensing of drivers. The North Atlantic states with one exception for many years have had standard license laws, and the tendency has been constantly to tighten rather than repeal them. On the other side of the continent, California and Arizona have had the standard license law. In practically all the intervening region sentiment has been either lukewarm toward the license system or bitterly opposed to it. Legislatures and groups of influential citizens in those states seemed to have closed their eyes to the practicability of the system and its demonstrated effectiveness in the Northeast.

This anomalous division of sentiment continued until about four years ago. Since then a number of states in the non-licensing territory have adopted standard license laws, and many organizations that formerly opposed state adoption of such laws have changed their attitude. It seems probable, therefore, that the year 1935 will mark the passage of a considerable number of standard license laws.

That a standard licensing system is one of the most effective means of decreasing accidents is shown clearly by available statistics. The fatality rates in states where the standard law is in force, including mandatory examination of drivers and effective centralized administration—chiefly the North Atlantic and Pacific Coast States—make a showing approximately 30 per cent better than the non-licensing states. From 1926 to 1933 the motor-vehicle death rate in the former, in relation to gasoline consumption, dropped 25 per cent,

while the rate in the latter increased 14 per cent, as shown in Fig. 1. Table I explains the grouping used in the diagram. North Central States with substandard license laws show results little if any better than those in non-licensing states. The lowest rating from the standpoint of rate of accident increase is found in the South, where state licensing systems are practically unknown and few of the state motor vehicle departments have been put on an effective basis.

TABLE I. GROUPING OF STATES AS SHOWN IN FIG. 1

GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5
States Having Standard Drivers' License Law and Administration	States Having Substandard Drivers' License Law and/or Substandard Administration	Midwestern States Having No Drivers' License Law by 1930	Southern States Having No Drivers' License Law by 1930	Western States Having No Drivers' License Law by 1930
California	Arizona	Illinois	Alabama	Colorado
Connecticut	Indiana	Iowa	Florida	Idaho
Delaware	Maine	Kansas	Georgia	Montana
Maryland	Michigan	Minnesota	Kentucky	Utah
Massachusetts	Nebraska	Missouri	Louisiana	Wyoming
New Hampshire	Washington	North Dakota	Mississippi	
New Jersey	Wisconsin	Ohio	North Carolina	
New York			South Carolina	
Pennsylvania			Tennessee	
Rhode Island			Virginia	
Vermont				

Valuable data on this subject from entirely different sources are given in the paper, "Automobile Hazard in Cities and Its Reduction," by William J. Cox, Assoc. M. Am. Soc. C.E., published in TRANSACTIONS, Vol. 92 (1928). Using the loss records of the casualty insurance companies, Professor Cox developed a formula for the probability of accident to any person using the highways. He then compared the actual results in various cities with the computed results. The conclusion was that in cities within states having the standard license laws the hazard was from 25 to 30 per cent lower than the average.

It is significant that the fatality records of the standard licensing states not only show improvement immediately after adoption of the drivers' license law but make a progressively better showing through the years as compared with the non-licensing states, indicating the permanent and continuing value of the system.

Act III is a new act including provisions relating to the civil liability of motor vehicle owners under particular conditions, as when the owner is a unit of government or other public corporation, when the car is driven by some one other than the owner, when the person injured or killed is a guest, when the owner is a non-resident, and when the car is rented by its owner without a driver. The provisions of the act are based on those which have been adopted in a number of states with a view to preventing abuse and injustice.

Act IV, the safety responsibility act, embodies the principle that a driver convicted of a serious traffic violation may not drive again until he has established his financial responsibility by an insurance policy or otherwise, and that when a judgment involving payment of damages has been obtained against a driver he must satisfy the judgment as well as establish financial responsibility before his right to drive is restored. There are reasonable provisions applicable to the owner of the vehicle as well as to the driver.

Act V is the former act regulating traffic on highways, with certain revisions and additions. Three of these have been referred to—the revision of the speed restrictions, the rewriting of the lighting regulations, and the addition of provision for periodic inspection of motor vehicles. Other additions require the carrying of flares by trucks to protect traffic against such vehicles when disabled at night, and provide for the safeguarding of school buses.

Another important series of provisions in this act relates to sizes and weights of motor vehicles. The 1930 draft of the code provided maximum allowable dimensions but dealt with weights and loads only by a note suggesting classification of highways, with maximum allowable limits for the various classes. Since then the American Association of State Highway Officials, in cooperation with the U. S. Bureau of Public Roads, has recommended a series of allowable limits for lengths of single vehicles and combinations of vehicles, for wheel and axle loads, and for gross weights, the last being fixed by a formula designed for the protection of bridges. In 1934 the National Conference adopted all these recommendations of the highway officials with the exception of that relating to gross weights, which it felt should be left to the individual states.

Act V also includes a provision that "every motor vehicle to be operated outside of business and residence districts shall have motive power adequate to propel at a reasonable speed such vehicle and any load thereon or to be drawn thereby," and authorizes insertion of the maximum gross weight in the registration card, making it unlawful to operate with a greater weight. The purpose of this is to safeguard traffic against heavy vehicles unable to maintain a reasonable speed on ascending grades.

Exact uniformity is of the greatest importance with respect to the first part of Act V, covering the rules of the road. Court decisions hinge upon the exact language of these rules, and there are in existing laws numerous cases where variations result in confusion and make conscientious drivers unintentional law breakers. For example, the Uniform Vehicle Code requires a driver coming up to a through street protected by stop signs to stop and not proceed until any and all vehicles in the intersection or so near as to constitute an immediate hazard have passed; but it does not put on him the whole responsibility for keeping out of the way of drivers approaching at a considerable distance. In some states, however, the entire responsibility is placed upon the driver on the cross street, and he crosses the through street at his own risk.

In the work of the Conference there has never been any appreciable sentiment in favor of Federal traffic laws. It has been the virtually unanimous belief that state laws should be the basis of traffic control and that uniformity should be attained by concerted state action. However, in the last six years there has been a decided change in sentiment regarding the extent to which the state should have jurisdiction within the municipality. The 1926 edition of the Uniform Vehicle Code contained little or nothing pertaining specifically to municipalities. Virtually the only restraint placed upon them was to prohibit them from establishing lower speed limits than the state code provided.

MODEL MUNICIPAL TRAFFIC ORDINANCE DRAFTED

Soon after the first edition of the Vehicle Code was issued, a demand arose for a uniform or model traffic ordinance for cities and towns, and one was drafted by the Conference in 1928. During the summer of that year the New Jersey Legislature revised its traffic laws, and it is interesting to note it incorporated in the law much of the substance of the model ordinance. By 1930 the success of the experiment in New Jersey was apparent, and Wisconsin had followed suit. In that year the Conference placed many ordinance provisions in the state code. This included such matters as the meaning of traffic control signals, regulations regarding pedestri-

ans, and similar provisions applicable chiefly in municipalities, but in which uniformity both within the state and throughout the country was obviously important.

This transposition of matter from municipal ordinance to state code was carried further in 1934. By that time it had become apparent that about the only provisions desirable in a local traffic ordinance and not suitable for state law were those prescribing the details of parking, one-way streets, and similar local procedure, and those providing the local machinery for traffic regulation. It became clear also that the latter group were not of particular interest to the vehicle driver or the pedestrian and could best be in a separate ordinance. The present version of the Model Municipal Traffic Ordinance is therefore divided into three parts; local provisions which the driver and pedestrian need to know, administrative provisions, and basic provisions of state law that must be operative within the municipality to complete the system of regulation and that may or may not need to be repeated in the ordinance.

UNIFORMITY IN CONTROL DEVICES

Besides the Uniform Code and Model Ordinances, the Conference recommends still a third set of standards to complete the program of uniformity. This is a *Manual of Uniform Traffic Control Devices*—signs, signals, markings, and islands. This manual is a consolidation of a *Manual of Signs and Markers for Rural Highways* developed some years ago by the American Association of State Highway Officials and a *Manual of Street Traffic Signs, Signals, and Markings*, also developed some years ago for the Conference by the American Engineering Council. The growth of metropolitan areas and the merging of urban and rural conditions made it highly important that all these standards be combined under one cover and brought up to date in recognition of the extensive development in these devices and their application. This was done in preparation for the 1934 Conference by a joint committee of highway officials and the Conference under the chairmanship of E. W. James, M. Am. Soc. C.E., of the U. S. Bureau of Public Roads. The manual includes much information regarding installation, operation, and maintenance not heretofore available.

It is not intended that the standards in the manual be incorporated in either state law or local ordinance because they are, and doubtless for many years to come will remain in a state of development, which should not be retarded by rigid legislative action. The Code and ordinance, however, require the respective administrative authorities to adopt the approved standards, and the American Association of State Highway Officials has officially endorsed these standards for the states.

PROMOTING TRAFFIC SAFETY

One other document which deserves special mention was produced by the 1934 Conference—a general report entitled "Guides to Traffic Safety." This briefly summarizes the judgment of the Conference as to the steps that should be taken to promote street and highway safety not only with respect to legislation, but also with respect to administration, compilation, and analysis of accident records, engineering, education, law observance and enforcement, and traffic safety research. It is recognized that unceasing activity along all these lines is necessary to cope with the ever-increasing death and injury rate and financial losses due to accident and congestion.

In spite of these increases, which have continued at an alarming rate with the evidence of returning prosperity, there are abundant reasons to believe that conditions can be greatly improved by properly organized effort. First, a comparison of the records for children killed in motor vehicle accidents with those for adults since the national child safety educational movement started in 1922 shows clearly the effectiveness of this effort. In the following ten years adult deaths increased about 150 per cent, while child fatalities advanced only about 25 per cent, and actual decreases occurred in 1930, 1931, 1932, and 1933.

Second, the record of fatal accidents involving drivers of commercial vehicles, many of whom are under discipline in fleets, shows that there has been no increase since 1927, whereas the number of operators of private cars so involved has advanced about 46 per cent in the same seven years.

Third, accidents at railway grade crossings, which have been the subject of an intensive educational campaign carried on by railroads and safety organizations, have shown a remarkable reduction in recent years. Up to 1926 there was a steady increase every year, but thereafter the curve leveled off. Since 1930 there have been repeated reductions, and in 1933 grade crossing accidents were 30 per cent below the peak reached in 1928.

Fourth, and perhaps most important, is the experience already referred to with the drivers' license law in the states that have adopted it and backed it with proper administration. On the average these states show fatality rates more than 30 per cent lower than do states not having the standard licensing laws. It is the opinion of students of the problem that, with adoption and effective administration of the licensing law in all states, a reduction not merely of 30 per cent but of at least 50 per cent in accidents may reasonably be expected for the country as a whole.

IMPROVED PROSPECTS FOR LEGISLATIVE PROGRESS

The prospects for progress in uniform motor vehicle legislation are better this year than at any previous time. Nearly all the state legislatures are meeting this year. During the past two years they were so much occupied with measures to combat the depression that they had little opportunity to deal with traffic, even though its economic aspects were far-reaching. Now there is abundant evidence of keen interest, and the standards recommended by the National Conference on Street and Highway Safety have met with more general approval than ever before.

It is especially gratifying to find active support being given to the program by representatives of the Federal and state governments, notably through the Honorable Daniel C. Roper, Secretary of Commerce, Chairman of the National Conference; through Thomas H. MacDonald, Chief of the Bureau of Public Roads; and through the organizations of state officials concerned—the American Association of Motor Vehicle Administrators and the American Association of State Highway Officials.

In the ten years since the Uniform Vehicle Code was first issued, 35 states have adopted one or more of the acts or extensive parts of them, or have revised their existing laws to harmonize with the code. However, there is much to be done in many of these 35 states to bring about the adoption of the remainder of the code and to incorporate the latest revisions, as well as in the 13 states that have made no progress toward uniformity. From the best information available, it is estimated that only 40 or 50 per cent of the existing state motor vehicle laws are on a reasonably uniform basis.

Information with regard to adoption of the Model Municipal Traffic Ordinance and the standards for signs and signals is less definite. It is known, however, that

hundreds of cities and towns have put standard provisions into effect. Judging from the widespread interest now being manifested by municipal officials and cooperating organizations, a more rapid progress than ever before is anticipated.

Engineers have a great responsibility in this matter. In general theirs are the habits of mind and methods of approach which are particularly needed for the solution of the accident problem. In public life and in private organizations they hold many key positions which enable them to be most influential in furthering traffic safety.

Separation of Ways

By ROBERT H. FORD

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
ASSISTANT CHIEF ENGINEER, ROCK ISLAND LINES, CHICAGO, ILL.

ABSENCE of engineering technique is largely responsible for the chaotic condition popularly known as the "grade crossing problem" now confronting the American public. The situation is so aggravated that it becomes both a challenge and an opportunity for the engineering profession. Resourceful leadership is needed, combined with engineering technique and understanding of the economics of transportation. To these qualifications might well be added a sound knowledge of the fundamentals of location and broad-gage planning.

Qualifications of engineering leadership should include a basic knowledge of psychology and a practical understanding of politics, which Webster's dictionary defines as "the science and art of government.... The theory or practice of managing or directing affairs of public policy. . ." These two accomplishments are now as essential as a knowledge of mathematics. They constitute what might be termed the background of a suitable understanding of the workings of the political system under which approximately 200,000 duplicating and entirely unrelated subdivisions control the vast network of public highways constituting the national highway system.

A knowledge of psychology and politics is a requirement which appears necessary before the grade crossing problem can be systematically attacked with any hope of a final economic solution. The situation has apparently bulked so large in its engineering and economic aspects that no concerted effort has been made by the engineering profession to consider it in its true perspective. Perhaps this is the reason why, according to a prominent highway authority, grade separation is regarded "as incidental to road building and highway improvements." Whatever be the cause, the grade crossing problem has reached the stage where it must be considered as a matter for concerted national and state action, as evidenced by the fact that in spite of the many hundred millions of dollars that have already been expended by Federal and state authority, including contributions from railroads and other agencies, crossings at grade are being created by government agencies in one form or another in greater number each year than they are being separated by other government agencies. If to this increase be added the number of crossings annually created at highway intersections, especially on the more important improved highways, the situation appears alarming in its lack of proper planning and localized control.

This condition can be traced rather definitely to the absence of suitable technical and economic data. Also it is due to some extent to a failure to apply well-known engineering principles to a class of problems which are becoming increasingly complex with the increase in motorized transportation and highway building. There is an apparent need for greater uniformity in the application of what might be termed the basic principles of engineering research in their relation to the problem of competitive transportation facilities, particularly so in highway relocations and new highway construction. These are factors which will have to be more universally recognized before real progress can be made in the coordination of transportation facilities, concerning which there has been so much discussion.

It would seem also that the public has a right to expect some crystallization of technical thought and considered pronouncements from leading professional and scientific organizations as an aid in the formulation of legislative enactments and administrative regulations. Legislation must be amended since the root of much of the difficulty is in legislation which is out of step with the requirements of modern transportation methods. Probably some of the difficulty lies in the fact that problems of highway building and grade crossings are frequently regarded as local in character, when in fact they are usually of great public concern. As such they call for the same type of technical knowledge and information as does any other problem connected with the extension or improvement of the highways.

INTERRELATION OF TRANSPORTATION AGENCIES

It would seem that the time has come when technical knowledge should be substituted for superficial planning. Widespread maladjustments in transportation have resulted through failure to consider these matters as a part of a related plan that could be rather definitely stated and accepted by the agencies whose coordination is desirable. Within recent years, we have been catapulted into an age of mechanical transportation which must in the first instance be understood before the various forms can be coordinated, whether they be railways or highways or other principal agencies of transportation. Transportation in its essentially scientific aspects is probably the best known and the least understood of the major industries. If proof were necessary, it could be found in a critical review of the numerous official and quasi-public documents on the subject, particularly those of the past few years. This is not intended as a reflection upon many of the excellent and extremely valuable treatises on transportation or related subjects but rather upon the confusion in the technical and economic approach and the resulting debatable conclusions.

Highways have now become a vast network, constituting the public system. They are controlled, constructed, and maintained by an appalling number of duplicating and conflicting agencies. Grade crossings are irritating points on the highways forming part of the network. From an essentially scientific viewpoint the first concern is not whether a crossing should be separated

but whether in the public interest the particular highway on which the crossing is located should exist at all. If the highway or sectional road is necessary as forming a desirable part of an articulated system, the next concern might well be whether there may be possibilities for relocation or readjustment whereby one or possibly more crossings may be closed. Many grade crossings could thus be avoided without the necessity of expensive separation structures. If, however, a crossing cannot be so treated and is part of the existing system of highway improvements, a separation structure should be definitely scheduled as a part of the uncompleted section of the improvement program. Any additional appropriations for Federal aid to the states might well be concentrated on this type of construction before any material additions are made to the road-building program.

TYPICAL CONSTRUCTION WORK REQUIRED FOR TRACK ELEVATION IN URBAN AREAS

GRADE SEPARATIONS NEEDED

From incomplete data, and in the absence of better information, it is estimated that there are 235,800 highway-railway grade crossings in the United States, of which 100,000 need protection only, 45,800 require but minor attention, and 30,000 should be separated. Also it has been estimated that there are more than 60,000 such crossings which ultimately might be closed by relocation or by some form of proper planning. This would represent a capital saving of three or four billions of dollars and proportionally add to the safety and convenience of public transportation.

A few years ago it was required by public authority that the grades be separated between what was then a heavily traveled highway and the tracks of an important western railway. The work was finally accomplished by the construction of a subway at a cost of about $40,000. In less than two years, it was observed that for some reason travel over the improved road and subway had greatly lessened. An investigation revealed that a new highway which had been built a relatively short distance from the subway and which was somewhat shorter and more advantageous, was diverting the traffic from the original route. Thus conditions which only a short time before had appeared to require the construction of a subway, were now completely altered. If the roads had been properly planned and traffic coordinated in the first instance, the original investment would have been saved. In fact, it is doubtful whether this highway link would not have been abandoned entirely. In the city of Chicago there are a number of grade separations costing from $50,000 to $150,000 each that are seldom if ever used, largely because of conditions similar to those previously cited. Doubtless there are many similar cases throughout the country.

These facts are referred to merely as indicative of one phase of the responsibility of the engineering profession to the public and because they show the desirability of formulating principles which may serve to guide public authority so that at least it may avoid unnecessary and wasteful expenditures of this character.

COMPREHENSIVE PLAN SHOULD INCLUDE CLASSIFICATION AND COORDINATION

Although some very excellent work has been undertaken in several states in the way of highway classification, the fact remains that practically nothing has yet been accomplished in the way of general application. Furthermore, it seems unlikely that very much can be done until the problem is stated in a way that will enable it to be considered in its broader aspects. Especially should this be done from the standpoint of coordinating the various forms of interstate and intrastate transportation, as well as from that of safety and convenience of public travel. That a comprehensive plan is needed, no one can deny. Neither can there be any question that a closer relationship between the agencies of public transportation is desirable, or that the plan must be national in its scope and economic in application.

Federal aid and direction are necessary. The striking need is that through such direction and support state highway systems be suitably coordinated with the railroads so that they may be safely and efficiently operated with an ultimate decrease in the cost of public transportation, whether it be represented in dollars or in the more valuable currency of human life.

As far as known, data have not been assembled that would give even a rough idea of the number of important highway crossings in the United States. With respect to highway-railway grade crossings, the latest statistics of the Interstate Commerce Commission show, as already noted, that there were 235,800 such crossings in a railway mileage of 256,000 miles. With the exception of a few states, no attempt has been made to classify grade crossings with respect to relative hazard or to determine what duplicating crossings could be closed as a result of the improved highway system.

INCOMPLETE DATA ON CROSSINGS

Inability to classify crossings, or in fact to determine their relative location, has doubtless been due in part to incomplete data. Official maps do not show the relative location of highways and railways. This fault is now being corrected, however, and some very excellent official maps are being prepared by the Federal Board of Surveys and Maps from the sheets of the U. S. Geological Survey. Maps of this character are invaluable in highway planning, as well as in avoiding further unnecessary duplication of transportation agencies, of which there already is a large excess over the needs of traffic.

Largely as a result of emergency unemployment legislation, surveys have been undertaken in several states for a preliminary classification of highway grade crossings in order that the more important ones may be considered first for separation or protection. Relative hazards have been largely the basis for these studies, which have taken into consideration the trend toward acceleration of traffic and the introduction of streamlined trains. Classification has also been undertaken so that the crossings of high speed or heavy traffic railway lines would, so far as possible, be considered of prime

importance. However, these attempts are somewhat sporadic, and it will be some time before data of national scope can be made available.

DISTRIBUTION OF COST

One of the most effective deterrents to the solution of the grade crossing problem has been the failure of legislation to keep pace with the altered conditions brought about by motorized transportation and the consequent development of the highway system. It has resulted in the requirement of many public agencies that the railways should continue, as in the past, to assume substantial parts of the cost for grade separation. This demand has met with determined resistance from the railroads and with as determined support from various political subdivisions and other public authorities. It has been contended on the one hand that the railways are private transportation agencies and that the authority originally extended to cross highways carries with it perpetual acknowledgment of the necessity to continue to adjust railway facilities when and in whatever way the public interest—defined in many instances by short-sighted policies—demands. The railways have replied that they are private transportation agencies in name only. They have supported their claim with a wealth of statistics and examples to show that they were the largest and essentially the most necessary public agency of transportation, as well as the most ineffectual in their ability to control their own actions as a result of entangling and suppressive legislation.

Against this, public agencies have urged that the benefits or savings which would accrue to the railroads through reductions in operating expenses should justify substantial outlays for improvements of this character, regardless of the fact that the railways have had little or nothing to say about the locations. The railways point out that the demand for these improvements is caused by economic changes in public requirements as a result of circumstances beyond the control of any agency; furthermore, that their own financial difficulties have been brought about largely by the rapid development of these improved highways. They maintain that the public itself is responsible for what in many respects is a rival transportation agency, and should provide the additional funds to complete what it has started.

SAVINGS IN OPERATING EXPENSES DUE TO GRADE SEPARATION STRUCTURES OVERESTIMATED

The railways have furnished statistical information to show that the savings in operating expenses due to grade separation structures are greatly overestimated. Records have been furnished to support the fact that these savings, through reduction in claims for deaths and injuries, average only a relatively insignificant sum per crossing per year. This amount, together with other similar items, is really of minor consequence in comparison with the total cost of the projects and the great benefits accruing to the public as users of the highways. Of late attention has been called to the fact, now generally recognized, that the railroads are without funds. Furthermore there is no possibility that they will ever have sufficient resources for even a small part of the cost of so great an undertaking as the elimination of all highway-railway grade crossings. The effect of these constantly recurring controversies on cost apportionment has served in many ways to aggravate the situation and increase the difficulty of securing the desired grade-crossing elimination. In perspective, however, it can be seen that there has been a marked trend away from these arbitrary and excessive requirements.

In this connection, Thomas H. MacDonald, Chief of the Bureau of Public Roads, has recently stated:

> As a fundamental in the extension of safe traffic facilities, there is a need for a national program of railroad grade crossing elimination. The whole theory upon which most state laws are based, of placing a large percentage of the cost upon the railroads, must be discarded. There is no use arguing the equities involved. If there is to be adequate progress in this undertaking, the highway funds will have to bear the major burden of the cost.

Whatever may be the reason for the increase in railway-highway grade crossings or for the failure to adopt a more rational plan for elimination and cost apportionment, the fact remains that the problem has now become so pressing that the public is not inclined to wait for long and difficult processes. No more are they willing to bear excessive tax burdens to continue systems of road control which have been made antiquated by the revolution in public transportation requirements. The immediate question appears to be: How can a way be found that will enable the grade crossing problem to be attacked in a practical way on a broad national front with a minimum of mistakes and maximum of immediate as well as future benefits?

ADVOCATING CENTRALIZED CONTROL

In this age of motor transportation, it is startling to find that, exclusive of city streets, 3,035,986 miles, constituting 87.8 per cent of the entire highway mileage of the United States, is directed and controlled in much the same primitive manner as it was in early Colonial days. Although of course there has been a substantial improvement in methods of building and maintenance for all classes of roads, nevertheless the administrative organization for substantially seven-eighths of the mileage has remained essentially the same as it was in those early days. Considering the splendid network of Federal-state highways, unsurpassed in excellence by any country in the world, it seems incredible that a system of highway control should prevail that limits the usefulness of an expert organization, able to produce such a network, to an average of about one-eighth, or 369,537 miles, of the total United States mileage, the other seven-eighths remaining in the hands of miscellaneous and largely duplicating and uncoordinated public authorities.

A SIMPLE BUT EFFECTIVE GRADE-SEPARATION STRUCTURE
Montreal-Ottawa Highway Carried Under Railroad
Near Vaudreuil, Quebec

A national plan for grade separation and related problems is needed, not only in the interest of transportation but for the good of the country as a whole, and it should be sponsored by the Federal Government. It is a matter of public benefit, as all would profit from it directly or indirectly, whether from greater safety and convenience,

from increased social and industrial opportunity, or for other reasons. The fairest and most equitable distribution of the cost of these benefits is therefore to the public as a whole, on much the same principle as the present practice regarding highway grade intersections.

With the single exception of schools, the cost for highway maintenance and operation forms the largest single item of public expense. It has been estimated that approximately 26 per cent of the tax dollar goes for highways. Viewed from the standpoint of science or economics, the uncoordinated highway problem with all its related factors, including grade crossings and unnecessary branch or other roads, is probably the most attractive field for engineering leadership and technical opportunity. Plans by which waste and wasteful methods may be eliminated are basically problems for the engineer.

Prevention of Highway Accidents

By JOSEPH J. DARCY

DISTRICT ENGINEER, HIGHWAY DEPARTMENT, BABYLON, LONG ISLAND, N.Y.

THIRTY-FIVE thousand five hundred of our countrymen were killed on the highways last year. Nearly a million more were injured, many of them maimed for life, and the property damage resulting from highway accidents totaled many hundreds of millions of dollars. This terrific loss of life, health, and property demands immediate and positive action by those charged with the responsibility of building highways.

The basic reason why the highways are unsafe is that with comparatively slight improvement, a right of way and other facilities which were originally designed for the accommodation of horse-drawn traffic are being used for the traffic of today. Ever since the construction of the highway systems was begun, their design has been several steps behind the traffic needs of the users, and instead of improving the situation, we are continually losing ground.

TRAFFIC CONGESTION—A BASIC DIFFICULTY

The principal cause of highway accidents is traffic congestion, and the first thing to be done in making the highway safer is to construct additional arteries to reduce such congestion, particularly in cities and suburban areas. Herein lies one of the most difficult problems of the highway engineer. Because of the enormous value placed on the land necessary for adequate rights of way in thickly populated areas and the heavy construction costs of a modern traffic artery, it is absolutely essential that the engineer be in a position to prove definitely to the public the economic soundness of such a project.

Loss of time is by far the most important item on the bill which the public pays for traffic congestion. It is not very difficult, with a scientific traffic survey in hand, to compute with reasonable accuracy the amount of time lost because of congestion. As far as commercial vehicles are concerned, determination of the value of the lost time is not extremely difficult. The problem of determining the value of time lost by people traveling in passenger vehicles is very complex, but it is one of the most important to be solved.

What is time worth? If some one would give the answer to this question, and an answer that could be irrefutably sustained, the absolute economic necessity of hundreds of miles of superhighways, parkways, railroad grade eliminations, and in fact, all classes of highways could be proved. With this proof in hand, it should be possible to obtain sufficient funds to at least partially eliminate traffic congestion and thereby tend to overcome the first and major problem in safety.

DANGER OF IMPROPER USE OF HIGHWAYS

Improper use of highways is the second most serious cause of highway accidents. The three principal factors are:

1. Failure of operators of automobiles to obey the laws and rules concerning proper use of the highways.
2. Licensing of drivers who are incompetent to operate motor vehicles because of physical or mental defects, age or temperament, or insufficient intelligence.
3. The operation on the highways of vehicles which themselves are unfit for use because of mechanical or other defects.

A recent survey in Nassau County, New York, disclosed the fact that traffic violations at certain intersections were often over 50 per cent of the total traffic count. These included speed violations, failure to come to a full stop before entering main arteries, failure to signal turns, failure to yield right of way, wide right turns, short left turns, passing on the right, parking on the roadway pavement or too close to it, and driving to the left of the center line.

Uniform laws and regulations throughout the country and their rigid enforcement by an adequate police force over a period of years will eventually reduce accidents from these causes. We as engineers can materially assist in this respect by obtaining and disseminating authentic facts developed by a real research organization.

THE ENGINEER'S RESPONSIBILITIES

In charging the greater number of accidents to traffic congestion, failure of operators to observe existing laws and regulations, incompetency of drivers, and unsafe vehicles, I am not trying to evade the more direct and immediate responsibility which rests upon me as a highway engineer to design, construct, and maintain safer highways. The engineer has been handicapped from the beginning because he has been trying to take an old road, street, or other highway facility and reconstruct or improve it sufficiently to meet modern requirements.

An examination of any highway system—whether Federal, state, or county—will reveal that it consists of a combination of old roads. In almost every state and county throughout the country the first hard-surfaced roads outside the cities were constructed in locations designated by the politicians then in power, and naturally at places where they would bring the maximum return in votes rather than in service. As traffic increased, public demand forced the connection of these roads into the semblance of a highway system. Today very few of the states have a system laid out by competent engineers. With very few exceptions even the planned system of highways is at best a result of compromise rather than a real engineering solution. The first work of the highway engineer is therefore to promote a rational plan for a system that will best serve travel needs.

Failure to secure an adequate width of right of way when construction begins is another basic error, which will result in a terrific charge for future widenings. The

desirable width depends upon the type of artery being constructed. At present in metropolitan areas in New York State 250 ft is the minimum desirable width for parkways. For the reconstruction of existing highways a width of 90 ft is obtained if property damage is not excessive, in which case it may be reduced to 80 ft. On the new 16-mile extension of the Sunrise Highway in Suffolk County, New York, by-passing villages on the south shore of Long Island, and largely placed on new location, a right-of-way width of 148 ft was obtained to provide for two main roadways and two future service roads. Undoubtedly time will prove that a width of 160 to 180 ft would have been better.

On all main arteries that justify a paved width of 40 ft or more, a divided pavement should be used. Traffic in opposite directions should be separated by at least a 10-ft mall, which should be widened at intersections to 25 ft to provide for safer crossing of traffic and left turns.

All first- and second-class roads should be divided into traffic lanes. The minimum width of a lane for modern high speeds should be 10 ft. On a four-lane undivided parkway pavement with a low curb, we are now designing with four 11-ft lanes. With an undivided pavement, it would appear that four lanes constitute the maximum width on which traffic can be controlled. On an artery where the pavements for traffic in opposite directions are separated, three lines of traffic in each direction can be controlled satisfactorily. On these separate roads of three lanes each, the middle lane should be 10 ft wide and the two adjacent ones 11 ft. On highways being developed in stages, where the roadway is divided by a center mall, if at the beginning two lanes in each direction are constructed with the idea of widening them later to a total of 32 ft, it is almost essential that an improved shoulder be provided to avoid accidents. It would appear that 20 ft of pavement without an improved shoulder is not sufficient for satisfactory handling of high-speed mixed traffic.

HIGHWAY AND RAILROAD-CROSSING SEPARATIONS

On any highway the most likely place for accidents is at intersections. The only safe intersection on heavily traveled arteries is a grade separation. The ordinary clover-leaf design gives satisfaction in most instances. It is our practice to add an extra lane of pavement at the intersection of the approach roads to provide for the change in speed of vehicles entering or leaving the main routes. In cases where the heaviest volume of traffic takes the main artery to the left, it is compelled, with the clover-leaf grade separation, to make a 270 deg turn to the right. This can be avoided by the construction of an additional bridge farther on to serve this volume of traffic by a left turn either under or over the traffic flowing in the opposite direction.

Railroad grade crossings are unquestionably an important source of accidents. As a result of early attempts to eliminate this long-recognized hazard, there are still on our highway system hundreds of grade separations which, because of dangerous approach alignment and grade, present a more serious hazard to modern motor traffic than did the original grade crossing. All such structures should be rebuilt immediately, present crossings at grade eliminated, and the work paid for with public funds. The old idea that the railroad should pay at least half the expense is obsolete. Practically the entire benefit, with the possible exception of locations within cities, accrues to the highway traffic rather than to the railroad.

One of the most important problems in connection with the detailed design of pavements arises from the fact that the engineer does not know what to anticipate from the manufacturers of automobiles. Highways that were fairly satisfactory as to alignment 10 or 15 years ago are full of death traps today. In the construction of arterial highways and parkways in Long Island the endeavor is to obtain a minimum radius of 2,000 ft, decreased to 1,000 ft only where absolutely necessary. Ordinarily the grade is kept down to $3\frac{1}{2}$ per cent, but a 5 per cent grade under favorable conditions is not considered serious. A 7 per cent grade is the absolute maximum. By the use of

FOUR-LANE PAVEMENT WITH ACCELERATING LANES
Traffic on Causeway to Jones Beach, Long Island, N.Y.

long vertical curves, a sight distance of at least 1,000 ft is sought, and on high-speed arteries that of 500 ft is the minimum allowable.

The surface of the roadway should be smooth enough for easy riding and of a texture as nearly skidproof as possible. For the Long Island territory, concrete with a well-broomed surface has been found satisfactory. Some of the newer types of asphalt pavements are a decided improvement over the older ones in the matter of providing a non-skid surface. Whether or not the good features of this surface can be maintained over a period of years under heavy traffic remains to be seen. For extremely heavy traffic, granite block and modern brick pavement give satisfactory surfaces. However they are very expensive in New York. The most dangerous of all pavements is the wood block, and because of its slipperiness when wet its use should be avoided.

All pavements should be constructed with permanent traffic lines, not only dividing the lanes but also along the edges next to the shoulders. These lines are of decided value in keeping the thoughtless driver where he belongs, a substantial assistance to traffic on rainy nights, and a real godsend to the man who is forced to drive in a heavy fog, particularly after dark.

All curves over 2 deg should be banked. The amount of banking must of necessity vary, depending on the speed with which the highway is to be used at the particular curve. Where an extremely sharp curve, with consequent heavy banking, must be incorporated in the design, the pavement for traffic in one direction should be separated from that in the other to prevent a vehicle on the outside from sliding in toward one going the opposite way. This applies to localities which are frequently subject to ice conditions. Of course, by this method another hazard is introduced at the point where the pavement is divided. Care must be taken in selecting these points of division. They should be placed where there is a relatively long sight distance and preferably where the alignment curves to the left.

Every pavement should be provided with a shoulder at least 8 ft wide. On highways carrying heavy truck traffic, this should be increased to 12 ft and the surfacing

should be gravel, crushed stone, or other material to a sufficient depth to sustain a loaded truck. A great many serious accidents, most of them fatal, are due to the parking of trucks on the pavement proper.

FUNCTION OF TRAFFIC LIGHTS AND SIGNALS

Without question the traffic light has been the means of preventing more accidents than any other single device. The principal drawback of the fixed-time signal is that it seriously delays traffic on one route when there are no vehicles using the crossing on the intersecting route. The modern vehicular actuated light is a decided improvement. Within a year or two this type probably will replace the old fixed-time signal, except at intersections where the flow of traffic is even and constant.

SEGREGATED TRAFFIC AND CIRCLE AROUND WATER TOWER
Jones Beach, Long Island

The lack of a uniform and adequate system of warning and danger signs as well as directional markers is a frequent source of accidents. Reflector button signs are a decided improvement over older types. However, on heavily traveled roads at particularly dangerous locations, flood lighted or illuminated signs should be used. The proper lighting of main highways carrying heavy traffic in congested areas will do much toward reducing the number of accidents. It will permit driving with only parking lights on the vehicles and eliminate accidents resulting from headlight glare.

Another type of accident which occurs frequently and is often fatal is due to pedestrian traffic on the pavement. The Nassau County survey indicates that approximately 11 per cent of the traffic accidents involved pedestrians and that half of these took place at points other than regular crossings. The construction of first-class sidewalks adjacent to the property line is the best method of reducing these accidents. There is not, and never has been any bona fide reason why a satisfactory walk for pedestrians should not be constructed along the roadway, particularly in built-up communities.

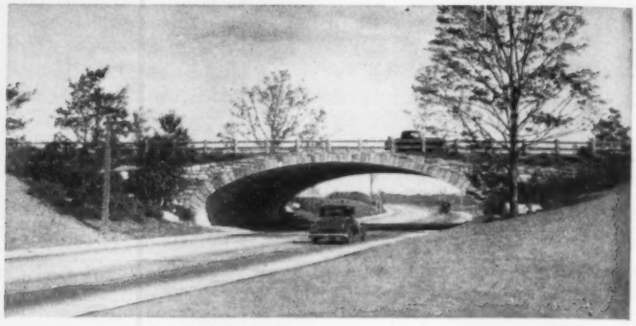
MAINTENANCE AS A SAFETY FACTOR

Intelligent maintenance can play an important part in making and keeping the highways safer. Certainly the road surface must be kept free at all times from holes or depressions. The shoulders should be maintained flush with the highway pavement and, at least adjacent to the pavement, should be constructed of material of sufficient stability to support a heavy car or truck going at high speed. Drainage structures should be kept clean and care should be taken to see that the surface of the road is properly drained.

In the northern and central sections of the country icy pavements present a serious maintenance problem. It is the present practice to spread cinders, or coarse sand that has been treated with calcium chloride. Although this method helps to relieve the condition if and when the maintenance organization gets around to apply it, the traveling public will demand and obtain a better solution.

Obstruction of sight distance by advertising signs and by the display of merchandise in front of roadside stands within the past few years has been given considerable attention, and conditions are rapidly improving. Strangely enough, most of this improvement has been brought about by those interested in the appearance of the roadside rather than by those who are trying to make the road safer.

It is my contention that if this problem of making the highways safe is to be solved, along with hundreds of other problems confronting the highway engineer, it must be attacked more boldly. This conclusion is based principally on my own observations during an entire lifetime spent in contact with highway problems, supplemented by what I have been able to learn of the opinions of others formed in the same way. Highway engineers as a whole have never thoroughly studied and analyzed their problems. Much individual energy and study have been expended in seeking solutions, and a few states and the Federal Government have conducted some commendable research, but the great majority of improvements in highway construction have come after individuals, or at best small groups, have arrived at a new conclusion by the trial-and-error method of building and observing a resulting failure.



WANTAGH PARKWAY CROSSING OVER SOUTHERN STATE PARKWAY

For example, although engineers have had over 20 years of experience in the construction of concrete highways, representing an investment running into the millions, it was only 5 or 6 years ago that they discovered the old joint construction to be wrong. Yet it had apparently always been obvious that if the full benefit of the concrete slab in distributing the load to the subgrade was to be obtained, some method of transmitting the load from one slab to another at expansion joints must be provided. Even yet no very satisfactory solution of the problem has been discovered. True, experiments have been conducted with various types of dowels and supports in the pavement, and after five or possibly ten years, the roads in which these have been incorporated will begin to show their merits or demerits.

SUPER-RESEARCH ORGANIZATION NEEDED

Suppose for a moment that the business of constructing and maintaining roads in this country were handled by a business corporation, for convenience termed "Highways, Inc." Assume that the dividends of this corporation would be commensurate with the actual service provided. Would the executives of such an organization be satisfied with the half-hearted research with which

the highway industry in this country is endeavoring to get along? The answer is emphatically "No!" How long would the executives of such an organization retain their positions if, after having invested the company's funds in highways built to give satisfactory service over a period of 10, 15, or 20 years, they were compelled to go before the board of directors at the end of 6 or 8 years to request additional appropriations for the reconstruction of the original highways because their alignment, grades, and even their pavements had failed to meet the requirements of traffic?

Highways, Inc., would without question be the largest single industry in the United States. Almost the first act of the corporation would be to establish a research organization to study the entire problem. This organization would gather pertinent facts relative to existing and future needs of traffic and would compile them for study by a group of the keenest minds available. Immense research laboratories would be built. Pavements of all types would be constructed and subjected to intensive traffic under conditions simulating as nearly as possible those encountered in the field. With modern methods of insulation, heating, and refrigeration, with sun lamps, delicate instruments for measuring the slightest movement, and the many other mechanical devices necessary, it should be possible in a few months to subject a test road to all the stresses and strains and other deteriorating influences that the ordinary highway undergoes over a long period of years. An efficient business organization would certainly use every possible means to get the correct answers and get them as quickly as possible.

An up-to-date system of keeping records would be instituted. The slightest failure of any type of construction anywhere on the system would be reported immediately, and such reports would be assembled and carefully studied with a view to permanent correction of the defect. A large corps of men would be intensively studying highway traffic under all conditions. Every accident would be thoroughly investigated and reported according to a uniform system. All the information gathered by Highways, Inc., and all the conclusions reached after tests and studies, would be promptly published and disseminated throughout the organization.

If safer highways are to be built—highways that will continue to be safe for years to come—a great national research organization must be set up, composed of men of vision and resourcefulness who, after determining the right course, would have the ability and courage to force its adoption. This organization should have an immense staff of the best trained and most highly compensated men in their fields to make a thorough study of accidents and their prevention, to decide on present traffic demands and forecast future ones after intensive study of all methods of transportation, population trends, and the motor car of the future, and to make recommendations as to traffic arteries and systems which would best serve our ultimate needs. Even if the findings of such an organization eventually proved to be only 60 per cent correct, this method of solving highway problems would be far superior to the cut-and-try, and largely individualistic or provincial methods at present employed.

MODEL OF A COMPLICATED SEPARATION PROBLEM
At Intersection of Northern Boulevard, Astoria Boulevard, and Grand Central Parkway Extension

A LONG ISLAND GRADE SEPARATION PROJECT—WANTAGH PARKWAY PASSING UNDER LONG ISLAND RAILROAD AND SUNRISE HIGHWAY
Property Condemnation for Access Road Decrease by Use of a Local Street

Sewage Disposal in the City of New York

Inadequacy of Funds Delays Construction of the Many Plants Required to Protect Against Dangerous Pollution

By RICHARD H. GOULD, M. AM. SOC. C.E.

ENGINEER IN CHARGE OF SEWAGE DISPOSAL AND INTERCEPTING SEWERS, DEPARTMENT OF SANITATION, NEW YORK, N.Y.

IN spite of unusual natural facilities for sewage assimilation in New York harbor, the necessity for some other method of disposal for the city has been apparent since the beginning of the century. To date 16 treatment plants have been built serving 1,250,000 people, and jurisdiction over disposal has been centralized in the Department of Sanitation. Although the existing plants daily pass flows of 136 mgd, they do not carry treatment to a high degree and are inadequate for present requirements. Of the 38 plants now proposed to reduce the nearly intolerable pollution of natural waters in the metropolitan area, $5,500,000 has been spent on the Wards Island activated sludge disposal plant, and a request for $25,000,000 more to complete this plant and the collecting system for it has been made to the Public Works Administration (PWA). The only other new plant immediately contemplated is the chemical precipitation plant at Coney Island, for which bids were received in January 1935. As explained by Mr. Gould in this abstract, prepared from a paper presented before the Sanitary Engineering Division on January 17, 1935, during the Annual Meeting of the Society, present expenditures for sewage disposal in the city of New York are too small to meet requirements. However, an insistent and growing sentiment for adequate sewage disposal will doubtless result in additional construction in the near future.

ALTOGETHER there are 16 sewage treatment plants in operation in the city of New York. The oldest dates back to 1884, and six were built prior to the formation of the greater city in 1898. These old plants were built mostly under the Powers patents using the chemical precipitation process. They have since been reconstructed, and additional plants have been built. At present there are eight fine-screening plants treating an average flow of about 93 mgd. In all but two of these pumping is required and in three of them chlorination is used. There are six plants with pumping, coarse-screening, and sedimentation facilities treating about 18 mgd. At one of these chlorination is employed, and all but two are so overloaded that they are effective chiefly as pumping stations. The two remaining plants pass a combined flow of about 25 mgd by gravity. Coarse screening only is provided in them.

These 16 plants serve approximately 1,250,000 people. As nearly as can be determined from somewhat fragmentary early records, they have cost approximately $5,000,000 to build. This sum was spent somewhat as follows: $520,000 in Manhattan, $1,600,000 in Brooklyn, $2,730,000 in Queens, and $170,000 in Richmond.

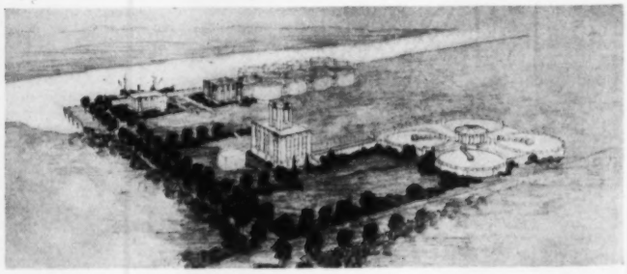
Although the existing plants are doing effective work within their limitations, their combined effect when compared to the magnitude of the problem is somewhat insignificant. Of the total sewage flow from the city discharged into the inner harbor, less than 3 per cent is passed through fine screens.

RESULTING POLLUTION A SERIOUS PROBLEM

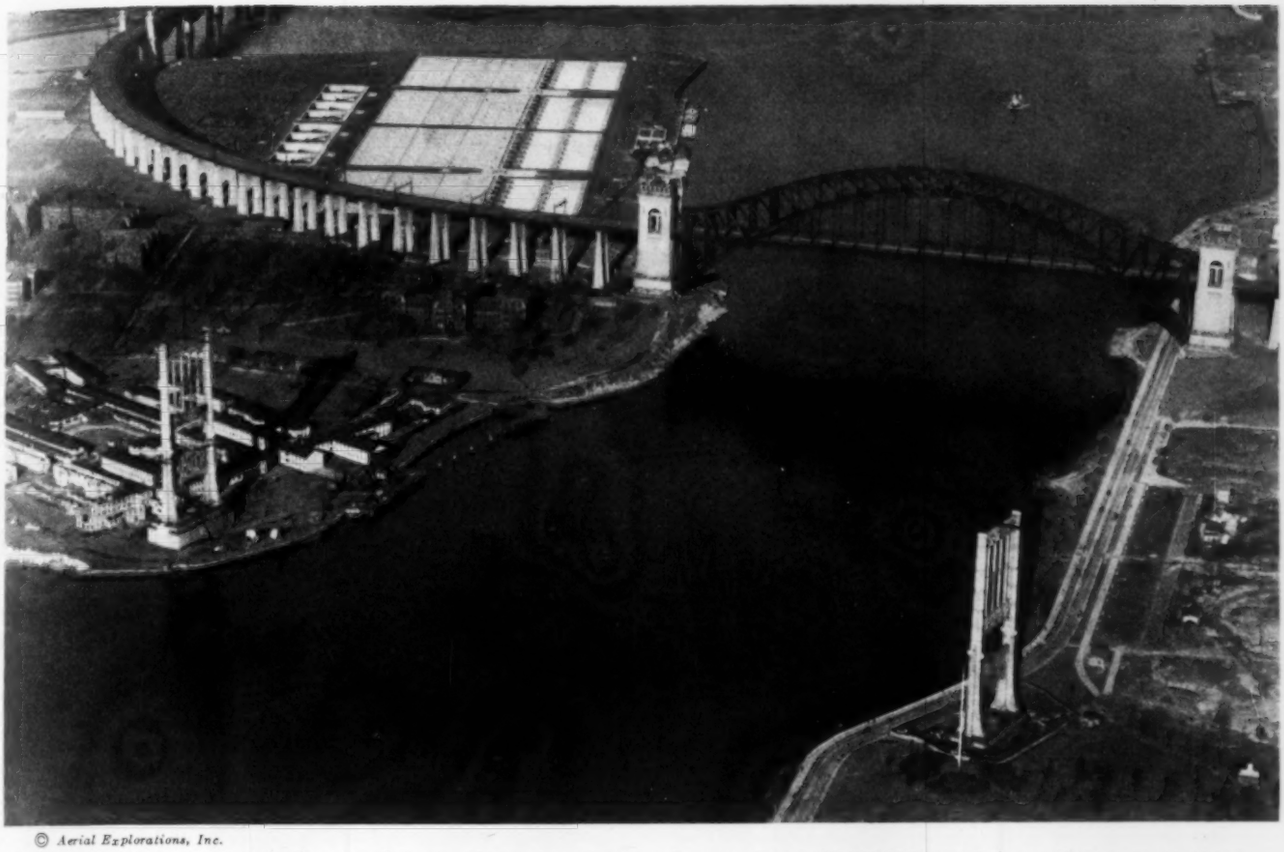
New York harbor is polluted not only by the residents of the city of New York but also by a large population living in New Jersey and in New York State outside the city. This is evident in an increasing degree with the growth in tributary population. It is apparent in the main body of the harbor in floating solids and turbidity of sewage origin. In slips, inlets, and other places of slack water, solids are deposited with the result that there is decomposition, ebullition of gas, and blackening of the waters. The dissolved oxygen content has been progressively lowered until the Harlem River and the lower East River are now in an extremely critical condition. In such streams as Newtown Creek, Coney Island Creek, Paerdegat and Bergen basins, and other local waters, the dissolved oxygen is entirely exhausted and the waters are in a state of active nuisance. That these offensive areas will be extended unless an adequate program of sewage treatment is put into effect cannot be doubted.

The problem is concerned not only with the restoration or maintenance of habitable conditions along the waterways, but also with the maintenance and restoration of at least a part of the waters for bathing and other recreational purposes. Conditions of bacteriological pollution are such that the Department of Health has prohibited bathing everywhere in the inner harbor from Sea Gate to Throggs Neck and also in Jamaica Bay. The only approved beaches remaining are those on the south shores of Staten Island, Coney Island, and the Rockaways, and in Little Neck and Eastchester bays. Even in many of these waters, conditions cannot be considered entirely satisfactory.

That pollution in the inner harbor is not worse can only be ascribed to particularly fortunate conditions of stream and tidal flow. Float tests made by the Metropolitan Sewerage Commission to determine the currents indicate a thorough mixing and interchange of waters between the different sections of the harbor. The amount of new sea water brought in by the tides appears to be surprisingly small. Most of the water going out



SKETCH OF PROPOSED CONEY ISLAND PLANT FOR CHEMICAL TREATMENT OF SEWAGE
First Contracts Awarded in February 1935



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WARDS ISLAND ACTIVATED-SLUDGE SEWAGE TREATMENT PLANT; COST TO DATE, $5,500,000, AND INITIAL CAPACITY, 180 MGD. Government Funds Are Sought for Its Completion. Also Observable Are the Hell Gate Arch of the New York Connecting Railroad and, in the Immediate Foreground, the Towers of the Suspension Span of the Triborough Bridge, Now Under Construction

on the ebb returns on the flood tide. Approximate figures at the Narrows indicate that only from 5 to 6 per cent of the total tidal flow consists of new sea water. This means that on the average it takes a long time for sewage discharged into the harbor to work its way out to the ocean. The displacement is due in part to fresh water inflow and in part to interchange with new sea water. For some locations, contact periods of sewage with the harbor waters of over 20 days have been determined. During this period settleable solids are deposited and many of the colloidal particles coagulate and come down as sludge. This may result in a fairly well purified effluent from the harbor, but it causes a heavy demand on dissolved oxygen within the harbor.

One disturbing condition indicated by the float tests from the standpoint of beach pollution is that fresh pollution from the upper bay can be carried to the end of Coney Island, near the bathing beaches, in one tidal run of about 6 hr. The outlet at Robbins Reef from the Passaic Valley Sewerage Commission's works is included in this same category. In spite of this condition the bacterial content of the water at the Coney Island beaches as a rule is surprisingly good.

In the summer of 1934 analyses of 24-hr bio-chemical oxygen demand were made for the inner harbor. They indicated that these waters had a demand of about 0.5 lb of oxygen per day per capita of the tributary population. This determination is a measure only of the oxygen demand in solution or suspension, but it was more than twice as large as the amount used in previous estimates.

Under the existing natural conditions it is quite clear that the removal of pollution in one section of the harbor has a beneficial effect throughout the entire body of water, and that this benefit will be very closely proportional to the organic load removed. Circumstances being as they are, these considerations are very important. In the congested sections of the city the difficulties and costs of securing treatment sites are great. A pertinent example is that of the Wards Island project. A large city-owned tract on this island is being utilized for the construction of an activated sludge plant with a capacity of 180 mgd, which probably will be doubled in the future to take in additional areas in the Bronx and Queens and to care for the expected growth in population. The removal of this large amount of sewage from the most heavily polluted parts of the harbor and the high degree of treatment by the activated sludge process will permit the construction of much simpler and more compact plants in the congested sections of Manhattan and Brooklyn. Once the sewage has been collected and pumped to this treatment plant, it is distinctly economical on the basis of unit cost of removal of organic matter, to carry the treatment to the high degree secured by the activated sludge process.

RESULTS TO BE ATTAINED

It is somewhat difficult to forecast what the requirements of the future will be as to standards of purity for the harbor waters. It seems reasonable to assume, however, that certain zones must be restored so that the waters will be suitable for recreational use. Obviously conditions of gross nuisance and obnoxious appearance must be removed. With the existing system of combined sewers, the harbor will always be subject to intermittent pollution because of the overflow of mixed sewage and rain water at times of storm. It appears economically unsound not to utilize the assimi-

lative powers of the harbor waters to a reasonable extent.

For those parts of the harbor not devoted chiefly to commercial purposes and suitable for recreational use, such as the upper Hudson, upper East River, Flushing Bay, and Jamaica Bay, it would seem that treatment should be carried to such a point that the waters will be attractive for boating and similar uses and not unduly hazardous for bathing. The ocean beaches at the Rockaways, Coney Island, the south shore of Staten Island, and in Little Neck and Eastchester bays should be preserved and restored so that bathing will be entirely safe from sewage pollution originating in the city of New York.

AVAILABLE TREATMENT PROCESSES

To accomplish these ends all sewage must be treated, but not by any means all of it to the same extent. It will not be necessary in all cases to secure as high a degree of treatment in winter as during the remaining months. For New York harbor, the conventional methods of rating the results of treatment must be used with caution. The ordinary five-day test for bio-chemical oxygen demand may not be a true measure of the effectiveness of plain sedimentation. The importance of sludge removal would appear to be much greater than is disclosed by the five-day test. The addition of chemicals may distort short-time tests by retarding bio-chemical action, thus giving results that are too optimistic.

In New York the selection of treatment processes is tied up with the question of available sites, possibilities for disposal of sludge, and degree of purification required. For the congested sections of the city, a short period of sedimentation or its equivalent is probably the solution. Chemical processes have come once more to the fore in the past few years, and in spite of extravagant claims from certain unreliable sources it is still felt that they have a distinct field in the city of New York. Particularly as regards intermediate treatment, the high cost of chemical treatment may be counterbalanced by considerations of compactness and lower initial cost.

In one of the Coney Island plants, a series of cooperative experiments are now being carried out by the Filtration Equipment Corporation and the City Department of Sanitation, in which the effects of sedimentation and rapid filtration are being compared with those of plain sedimentation. The experiments are being conducted in parallel, with various rates of chemical application and different rates of treatment. With this experience and that obtained under modern operating conditions in full-sized plants, it is hoped that the advantages and limitations of chemical treatment as applied to New York's problems can be determined.

Where an adequate site is available, power rates are low, and a high degree of treatment is required, the activated sludge process is looked upon with favor. At the rate of 7 mills per kwhr, with a load factor of 100 per cent, which will be available at Wards Island the power cost of air compression for aeration tanks is estimated as less than that for pumping and only from 35 to 40 per cent of the cost of chemicals necessary to effect a somewhat lower degree of purification. It is felt that the cost of power is less likely to fluctuate with changing market and industrial conditions than is the cost of chemicals. It is not thought that the activated sludge process has reached its ultimate development. No doubt, time will develop methods of less complete treatment by revealing modified principles of sludge reaeration, in conjunction with shorter detention periods, that may find application for the city's purposes.

As a final measure for protecting bathing beaches from direct bacterial pollution, dependence is placed on the well-tried process of chlorination. This will be necessary only during the bathing season and only for those plants critically located with respect to tidal currents and where the means for artificial and natural purification are otherwise inadequate.

Sludge disposal is a matter of vital importance. The screenings from present plants are in part burned in refuse incinerators and in part disposed of in isolated land fills. For the large plants the barging of liquid sludge and its disposal at sea ten miles or so from land has the advantage of simplicity and is the most economical method now available. It is in use in the metropolitan area by the Passaic Valley Sewerage Commission, and so far as known there are no valid objections to it as a means of disposal. Valuable fertilizing products can be recovered from sewage sludge, and probably attempts will be made along these lines. It does not now appear practicable from the standpoint of available sites or of economics to convert the sludge of the entire city into fertilizer. However, the Park Department has a large demand for fertilizer and it appears practicable to meet this to a considerable extent. Other methods of sludge disposal will be followed with interest as they are developed. It is by no means certain that the disposal of sludge at sea will be the solution for all time. The availability of this method is, however, one of the substantial assets of New York's location on tidewater.

GENERAL PLANS MADE

Several tentative comprehensive plans for sewage disposal for the entire city have been drawn up for the purpose of studying the costs and effects of different degrees of treatment. No rigidly final plan has been officially adopted. With the progress that is being made in the art, any plan must be subject to modification to meet altered conditions or newly introduced practices. The present tentative plan is shown in Fig. 1, on which 38 plants are indicated, together with the required intercepting and trunk sewers. Detailed data on these plants are given in Table I.

TABLE I. PROPOSED TREATMENT PROJECTS FOR BOROUGHS IN NEW YORK CITY

Numbers Refer to Locations Shown in Fig. 1

	Project	Ultimate Capacity in Mgd
Manhattan:		
1.	Wards Island	426
2.	East 41st Street	40
3.	East 19th Street	28
4.	Delancey Street	18
5.	Roosevelt Street	28
6.	Fulton Street	10
7.	Canal Street	13
8.	West 23rd Street	16
9.	West 46th Street	24
10.	West 72nd Street	22
11.	West 96th Street	22
12.	West 129th Street	23
13.	Fort Washington	16
14.	Dyckman Street	17
The Bronx:		
15.	Manida Street	80
16.	Classon Point	86
17.	Baxter Creek	19
18.	City Island	1
19.	Riverdale	2
Brooklyn:		
20.	Coney Island	140
21.	Owl's Head	193
22.	Red Hook	22
23.	Adams Street	35
24.	Broadway	25
25.	Newtown Creek	83
26.	26th Ward	60
Queens:		
27.	Tallman's Island	70
28.	Jamaica	130
29.	Rockaway	18
Richmond:		
30.	Port Richmond	45
31.	Stapleton	13
32.	Quarantine	5
33.	South Beach	9
34.	Oakwood Beach	6
35.	Princess Bay	5
36.	Tottenville	3
37.	Fresh Kills	8
38.	Bloomfield	4

The area tributary to the first installation of the Wards Island activated sludge plant is shown in Fig. 1 by cross hatching. This plant is partly constructed. Almost $5,500,000 has been spent on the project so far, resulting in the construction of the dock and sea wall, the primary

and final settling tanks with their sludge-removal mechanisms, the aeration tanks, and the foundations for the operating galleries and sludge storage buildings. No further construction work has been done here for more than a year and a half because of the financial situation. An application for a loan and grant to the amount of about $25,000,000 is in the hands of the Public Works Administration for the completion of the plant and the construction of the intercepting sewers, grit chambers, and connecting tunnels. The detailed plans for the entire project are complete.

CHEMICAL PRECIPITATION FOR CONEY ISLAND PLANT

Construction work is imminent at one other location, on the proposed Coney Island Sewage Treatment Works. The area tributary to the initial construction is also cross hatched in Fig. 1. An allotment of PWA funds has been made for this plant to the amount of about $1,867,000. Bids on the first contracts were received in January 1935. The first installation for the plant is to have a nominal capacity of 35 mgd—one-quarter of the ultimate development planned. The outfall to Rockaway Inlet will be large enough for about half the ultimate requirement.

The type of treatment selected for this plant consists of chemical precipitation by iron salts in conjunction with flocculation, sedimentation, rapid filtration, and chlorination. During the winter months chemical treatment and chlorination will not be used. Sludge digestion tanks are to be provided. Digester gases will be collected and used to generate electricity for sewage-pump operation and other plant uses. A vacuum filter will be included to recover digested sludge filter cake for use in building up humus in the large Marine Park to be developed nearby by dredging sand from adjacent waterways. Provisions will also be made for the disposal of sludge at sea.

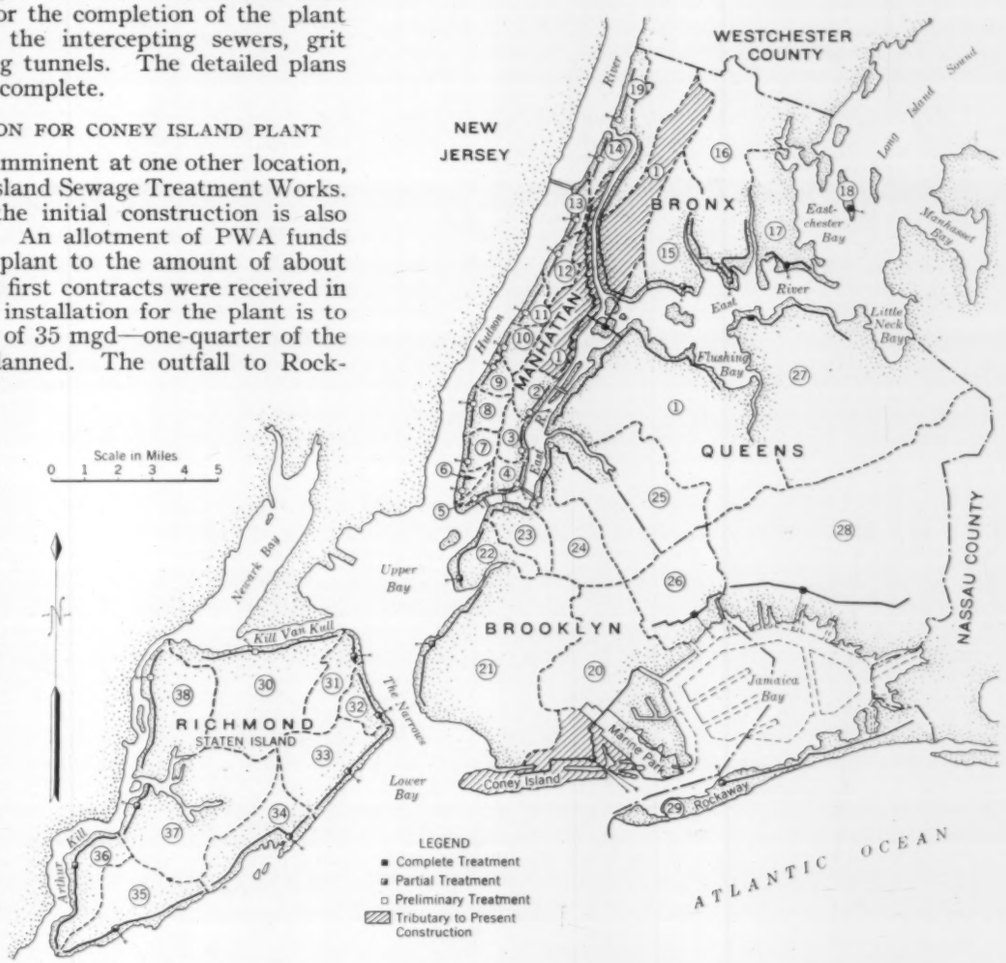


FIG. 1. TENTATIVE PLAN OF SEWAGE TREATMENT AND DISPOSAL FOR NEW YORK CITY

Some of the reasons that led to the selection of this form of treatment may be of interest. The site available is limited in extent and badly cut up by cross streets, which because of traffic conditions cannot well be closed. The size of the area is not adequate for the full development of an activated sludge plant. Also, the power rates in this section are abnormally high, and the very large dilution at the point of discharge at Rockaway Inlet makes unnecessary a high removal of bio-chemical oxygen demand. It is only necessary to bring about a high degree of clarification and bacterial purity during the relatively few months of the bathing season. These conditions of area of site, shortness of time for full operation, and degree of purification required, favor the compactness and lower initial cost secured by chemical treatment.

As to sludge disposal, the relatively small amount of sludge produced during the first years of operation and the undesirability of holding raw sludge at the plant for more than two days makes for small barge loads with relatively high towing charges. Shellbank Creek, on which the plant is situated, is subject to closure by ice conditions in winter. Digestion of the sludge reduces the quantity that need be barged, permits larger loads, and reduces the hazard from shipping tie-ups. The digested sludge can be applied to land without offense, and utilization of sludge gases for the production of power to be used in and about the plant results in lowered operating cost.

The rate at which New York will proceed with the further development of the sewage disposal program depends on many things, among which availability of funds is of first importance. The disposal of sewage has not yet become an important item in the city's budget expenditure. For the coming year, the funds appropriated for the Departments of Sanitation, Health, Hospitals, and Parks total the impressive sum of about $57,000,000. Yet less than 1 per cent of this amount has been allotted for sewage treatment. The desirability of the expenditures for cleanliness, health, esthetics, and recreation is not questioned, but the treatment of sewage has not yet received the attention that its importance, in reference to these considerations, justifies. There is an insistent and growing demand for the improvement of conditions resulting from sewage pollution, and it is felt that means will shortly be found to launch a substantial program of construction for this purpose.

Pressure of Concrete on Forms

Results of New Tests Indicate That Lighter Forms Than Are Now Used May Be Adequate

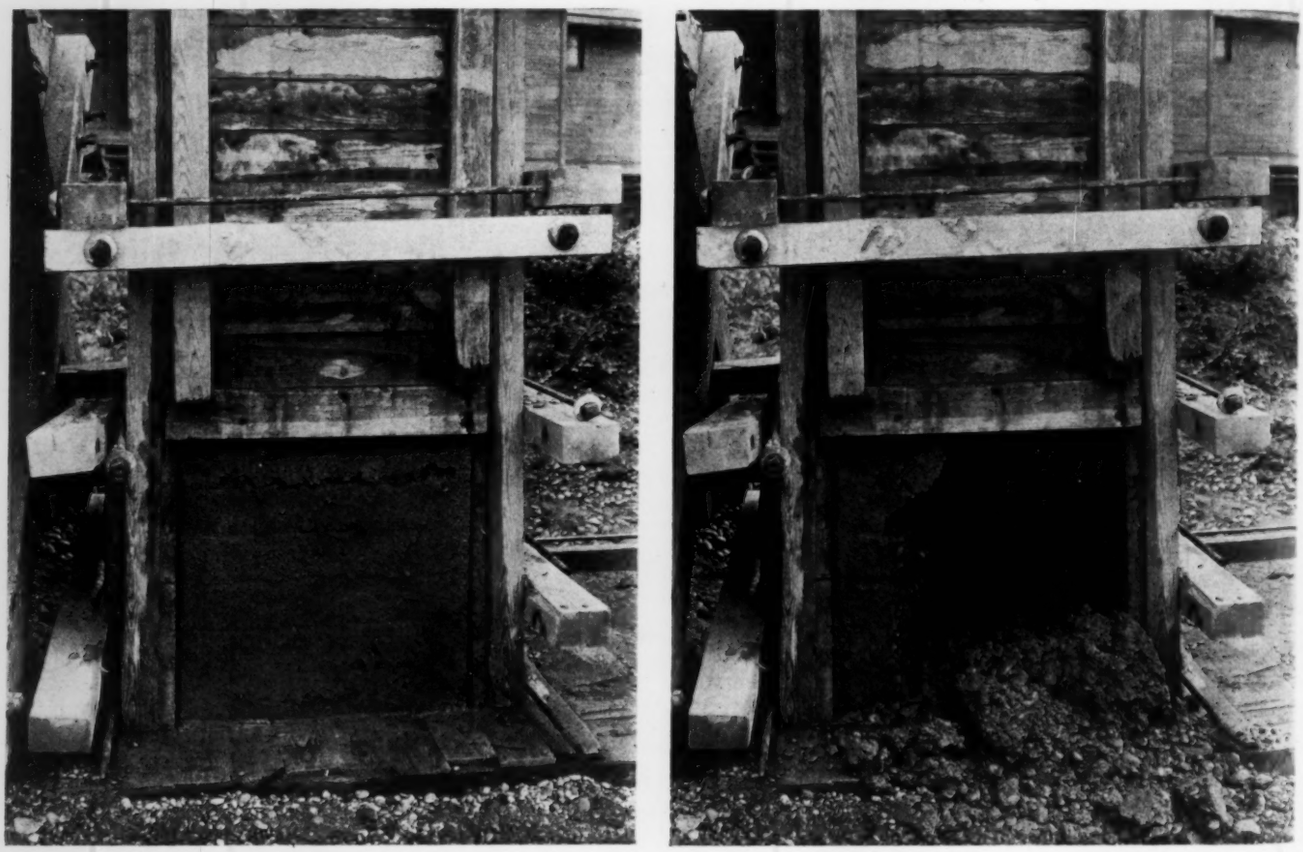
By Harrison G. Roby

Member American Society of Civil Engineers
Chief Hydraulic Engineer, Byllesby Engineering and Management Corporation, Chicago, Ill.

DATA on the pressure of fresh concrete on forms are inadequate and those available are conflicting. Tests described by Mr. Roby in his paper presented before the Structural Division on January 17, 1935, at the Annual Meeting of the Society, and here abstracted, indicate that the values recommended in textbooks are much too high. He found that, except for extremely rich mixes, the pressure rarely exceeded 800 lb per sq ft—about half that reported in Major Shunk's tests in 1908. In recent tests the pressure was found to vary with the speed with which the forms were filled, with the temperature of the concrete, with the amount of cement in the mix, and with the water content of the concrete. Although the pressure increase up to 4 or 5 ft of head closely followed the curve of theoretical pressure of a liquid weighing the same as fresh concrete, the rate of increase dropped off rapidly above that head. After reaching a maximum value, depending on the character of the concrete, the pressure actually decreased with still further increase in head. Of special significance is the fact that a mix poured in hot weather exerted pressures very much less than did the same mix poured during normal weather, and that lean, dry mixes exerted much less pressure than rich ones. Advantage of these facts can be taken by designing forms for the particular mix to be placed and for the conditions of pouring specified for the work.

CONSIDERING the high cost of form work as compared to the total cost of concrete, it is rather surprising to find how little has been done in determining the actual pressures resisted by the forms. A large part of all form work is built with no knowledge whatever of the pressures to be withstood. The carpenter foreman, drawing heavily on former experience and a few empirical rules, uses an unknown factor of safety, usually large.

In searching the records of former experiments, one is immediately impressed by the remarkable lack of reliable data and the wide discrepancies between the pressures reported by the investigators. Records of but two sets of tests were found which give pressures for the



Bottom Panel of Form Removed Immediately After the Maximum Pressure Was Reached
Left, Panel Off and Two Sides Spread to Remove Support; and Right, Firm Mass Dug Out with Bar

rates of placing commonly encountered in heavy construction, say from 2 to 10 ft in depth per hour. The first noteworthy set of experiments was reported by the late Maj. Francis R. Shunk, Corps of Engineers, U.S.A.,

TABLE I. CONCRETE MATERIALS AND MIXES AS USED IN CONCRETE PRESSURE TESTS

Materials

Cement: Standard	
Sand:	
Composition	Glacial quartz with coarse particles of mixed rock and limestone
Quality	Hard, durable, rounded, and uncoated grains
Size	0 to No. 4 mesh
Average fineness modulus	2.86
Average voids	40 per cent
Average weight per cu ft (dry)	99 lb
Silt	0.3 to 0.5 per cent
Organic matter	A trace
Gravel:	
Composition	Glacial quartz with a small percentage of limestone and sandstone
Quality	Hard, durable, rounded, and uncoated pieces
Size	No. 8 mesh to 1½ in.
Average fineness modulus	7.38
Average voids	40 per cent
Average weight per cu ft (dry)	103 lb
Silt	0.5 to 0.7 per cent
Organic matter	A trace
Water: City supply	

Concrete Mixes

	NORMAL	DRY	RICH	LEAN
Proportions	1:2:3½	1:2:3½	1:1¼:2¼	1:2½:5
Average slump	7 in.	3 in.	7 in.	7 in.
Batch quantities, in Cu Ft:				
Cement	0.43	0.43	0.43	0.33
Sand	0.87	0.87	0.54	0.82
Gravel	1.50	1.50	0.97	1.65
Water added	0.30 (2¼ gal)	0.28 (2⅛ gal)	0.23 (1⅞ gal)	0.27 (2 gal)
Water in sand	0.06	0.06	0.035	0.06
Water in gravel	0.03	0.03	0.015	0.03
Total water	0.39	0.37	0.28	0.36
Water-cement ratio	0.91	0.86	0.66	1.10
Concrete Characteristics:				
Weight in lb per cu ft	151	151	150	154
Design strength in lb per sq in.	2,400	2,700	3,800	1,700

in 1908, and his results have been copied and recopied in the concrete handbooks since that date. An account of his equipment and tests is to be found in the *Engineering Record* dated January 15, 1910, page 71. His measuring apparatus was rather crude, consisting of a cylinder and a leather piston with levers and counterbalancing weights. At each determination, the observer moved the piston in and out about ¼ in. until he felt it to be "alive." The recorded pressures were those at which the concrete followed up—that is, actually moved the piston out against a counteracting weight. At the time his results were published, the general opinion was that the pressures recorded were too high, but nothing was done to verify them.

In 1920 a set of experiments was reported by engineers in the U. S. Bureau of Public Roads. The apparatus used consisted of forms having an inside horizontal cross section of 7.8 by 9.1 in. and a height of 10 ft. The pressure was measured by cells similar to those used by the Bureau in determining earth pressures behind retaining walls and under fills. The results of the tests varied widely. The most interesting fact about them is that the maximum pressures obtained were only about 40 per cent of those reported by Major Shunk. With these conflicting values as a basis, the engineer who has attempted to design forms has naturally taken the higher ones to provide against springing or failure.

THE TESTING APPARATUS

In Fig. 1 are shown an elevation and a horizontal section of the test form used in my investigation. There is also a vertical section through one side of the form on which the deflection plate was installed. The form used was 15 ft high and 2 ft 6 in. square, inside dimensions. The pressure of the concrete was measured by the deflection of a 7/16-in. steel plate 6 in. wide, extending the full width of the form and resting on knife edges 28 in.

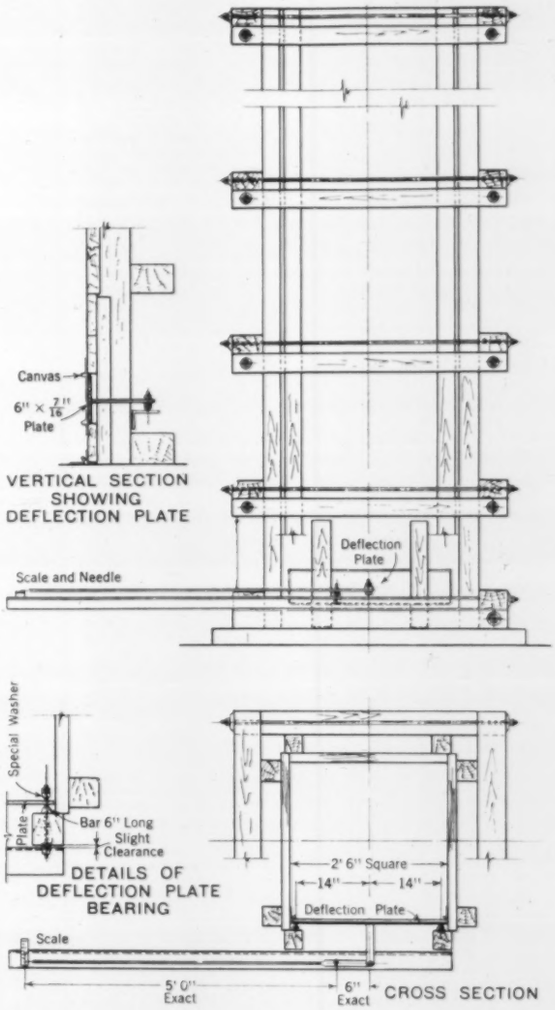


FIG. 1. TEST FORMS TO DETERMINE PRESSURE OF CONCRETE

apart, located on a side of the form near the bottom. The movement of the center of the plate was communicated to one end of a long bar, pivoted at a point

TABLE II. TIME OF INITIAL AND FINAL SETTING OF CEMENT

LOCATION OF STORAGE OF PAT	AVERAGE TEMPERATURE IN DEG F	ELAPSED TIME OF SETTING, IN HR: INITIAL	ELAPSED TIME OF SETTING, IN HR: FINAL
Ice cooler	45	6	11¼
Moist closet	70	3½	6¼
Room (pats cracked)	80	2½	4½

such that the other end of the bar would traverse a distance 10 times that of the plate deflection. The movement of the long end of the bar was read by a needle point which passed over a steel scale graduated to 1/64 in. By the use of a magnifying glass, this could be read to 1/256 in. It was possible therefore to observe the deflection of the plate to 1/2,560 in.

Above and below the deflection plate the form boards were made of such thickness that under load they would deflect the same amount as the plate, for the purpose of simulating as nearly as possible the action which takes place in a form when it is filled with concrete. The plate was given a small clearance on all sides, and the space between it and the surrounding form was covered by canvas strips. A canvas strip also covered the clearance space left between the lower form board and the floor of the form, thereby allowing free play between the board and the floor. Care was taken to prevent all deflections in the vertical posts from being communicated to the measuring system.

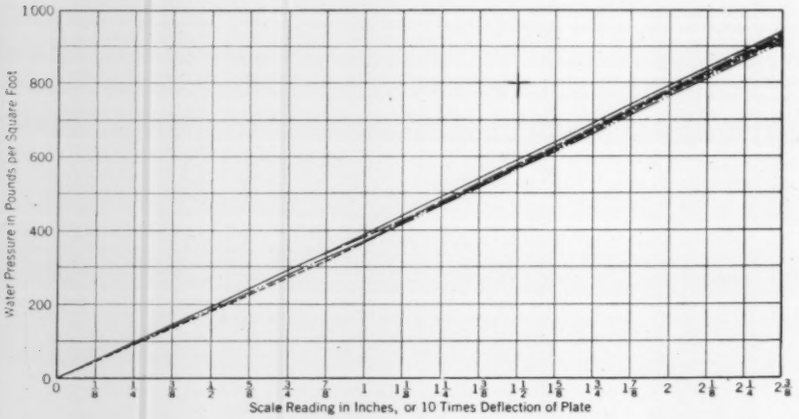


FIG. 2. DEFLECTION-PLATE SCALE CALIBRATED BY WATER LOAD

To calibrate the apparatus, a water load was first applied, readings being taken as the water level in the form reached the successive 1-ft marks measured above the center of the deflection plate. Since the water pressure per square foot for the various depths was known, the reading of the scale was easily calibrated, ready for recording the concrete pressures. In Fig. 2 are shown the results of the calibration. The widest variation between the water tests was about 25 lb in 900 lb, or 2.8 per cent.

CONDUCTING THE TESTS

Concrete was prepared in a small batch mixer, was wheeled to the top of the form in a barrow, and was there chuted into place. It was placed in 1-ft layers, the time interval between layers being regulated to give the rate in feet per hour desired for the test. The same amount of spading and puddling was employed as is customary in placing concrete in forms of this kind. The form and the deflection plate were lightly tapped to ensure an even distribution of pressure throughout the mass. The deflection needle was read before and after each successive foot of concrete was placed. Two or more tests were run for each set of variable conditions, so that the accuracy of the observations could be checked, one against another. In about half the tests, two similar experiments checked within 3 per cent, and the averages of all similar tests, when plotted, formed smooth curves.

In Table I are given descriptions of the sand and gravel used, the batch quantities, and the design strengths for the various mixes. In Table II is listed the time of initial and final set of the cement, under various conditions of air and temperature.

In all, 31 complete tests were run. The results are plotted in Figs. 2, 3, 4, and 5. The first group of tests was carried out in the early spring, when the temperature averaged about 60 F. The series was completed in midsummer, when the temperature was about 100 F. In order to maintain approximately the same temperature within each group of tests, the mixing water for a few of the later tests in the first group was cooled with ice as the weather became warmer. And for a few of the last tests in the second group the mixing water was heated slightly as the weather became cooler.

The action of the concrete showed plainly that for rapid placing—the rates used were 10 ft and 4 ft per hr—the initial set of the cement had very little to do with the development of maximum pressures. At the rate of 10 ft per hr, the maximum pressure was reached in 42 min after the first foot was placed, when the head was 8 ft. At the rate of 4 ft per hr, with a normal mix, this maximum pressure was reached in 75 min after the first foot was placed, when the head was 6 ft. It will be noted that these periods required for maximum pressure to be reached, are much shorter than the time of initial set.

In some of the tests, the condition of the concrete was inspected at the time when added concrete ceased to develop additional pressure. Immediately after placement of the first 1-ft layer that failed to show any increase in pressure, a panel was removed from the bottom of the form on the side opposite the deflection plate. A series of three photographs shows the conditions found.

An examination of the concrete indicates that, as its depth was increased, the mass was changed from a liquid to a solid, and some of the water was squeezed out. The mass was sufficiently strong not only to stand unsupported but also to carry the weight of the superimposed concrete. After this state was reached, no further lateral pressure was developed when placing was continued. This action of solidification was the same whether the concrete was placed at the rate of 10 ft per hr or 4 ft per hr. The slightly greater maximum pressure obtained for the faster rate of placing is probably due to the smaller influence of the incipient setting of the cement in

RESULTS OF TESTS

1. The pressure of concrete on forms is considerably less than the values for it usually given in engineering handbooks. For concretes of normal mix and at moderate temperatures, a rate of placing of 10 ft per hr will develop a pressure of about 800 lb per sq ft; a rate of 4 ft per hr, that of about 700 lb per sq ft; and a rate of 2 ft per hr, that of about 600 lb per sq ft.

2. An extremely rich concrete will develop much higher pressures than a normal mix. This increase in pressure varies from about 40 to 60 per cent, the lower percentage being for the more rapid rate of placing.

3. A lean mix develops pressures from 10 to 15 per cent less than a normal mix.

4. A dry mix develops pressures from about 20 to 25 per cent less than a normal mix.

5. Pressures developed during hot weather are less than those during moderate temperatures. Mixtures having a temperature of 100 F when placed will develop pressures equal to from 60 to 75 per cent of those developed by the same mixes at 60 F.

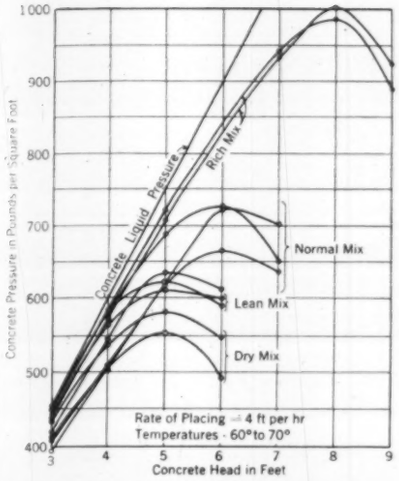


FIG. 3. EFFECT OF CEMENT AND WATER CONTENT ON PRESSURES DEVELOPED ON FORMS

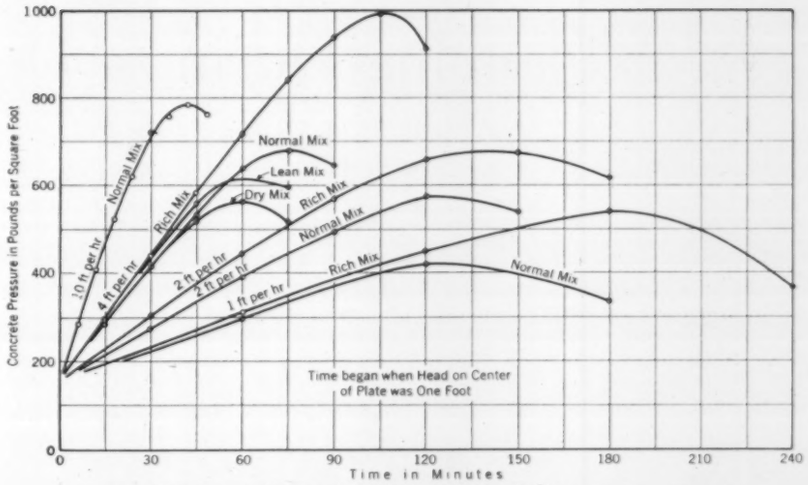

Concrete Pressure in Pounds per Square Foot
Normal Mix
Lean Mix
Dry Mix
Rich Mix
10 ft per hr
4 ft per hr
2 ft per hr
1 ft per hr
Time began when Head on Center of Plate was One Foot
Time in Minutes

FIG. 5. EFFECT OF RATE OF FILLING FORMS ON PRESSURE. BOTTOM PANEL OF FORM WAS REMOVED IMMEDIATELY AFTER THE MAXIMUM PRESSURE WAS REACHED

the shorter period of time. When the rate of placing is lowered to 2 ft per hr, and particularly when it is as low as 1 ft or $^1/_2$ ft per hr, stiffening of the concrete is brought about both by solidification due to displacement of water and by setting of the cement.

EFFECT OF CEMENT AND WATER CONTENT ON FORM PRESSURES

In Fig. 3 are shown the results of tests when placement was at the rate of 4 ft per hr, with changes in cement content and water ratio, but with the temperature maintained between 60 and 72 F. It is rather surprising to note that the cement content had such a large effect in determining the maximum pressures. The rich mix developed pressures of about 1,000 lb per sq ft, or about 42 per cent greater than the normal mix. It is of interest also to find that the rich mix placed at the rate of 4 ft per hr showed maximum pressures about 25 per cent greater than the normal mix placed at the rate of 10 ft per hr. Both lean and dry mixes developed pressures somewhat less than did normal mixes.

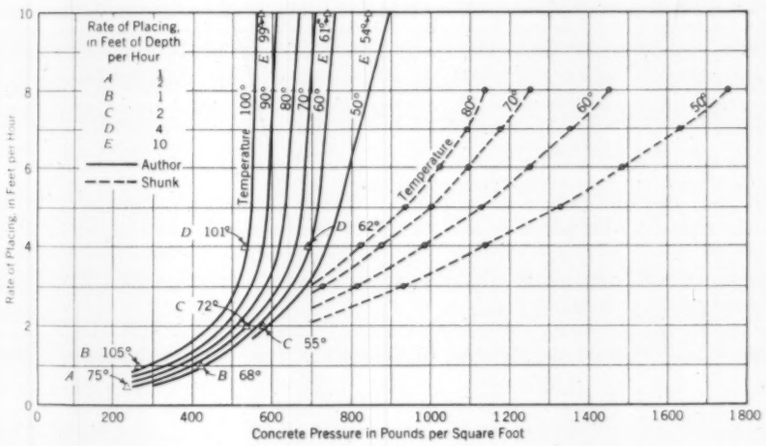


FIG. 4. EFFECT OF TEMPERATURE OF CONCRETE MIX ON FORM PRESSURES
Mr. Roby's Results Compared with Those of Major Shunk

Effect of temperature on the maximum developed pressures is illustrated in Fig. 4. As the temperature rose, the maximum pressures decreased. For the more rapid rates of placing, 10 ft and 4 ft per hr, the maximum pressures at 100 F were approximately 75 per cent of the maximum pressures at 60 F. For lower rates, the maximum pressures at 100 F were about $62^1/_2$ per cent of those at 60 F. A comparison of the pressures reported by Major Shunk and those obtained by me is also given in Fig. 4. It is evident that the pressures in his report are much the higher. A material saving in form work obviously could be effected by designing it for the lower values, which seem warranted by these more recent and more accurate tests.

In Fig. 5 is shown the relation of pressure to elapsed time, for placement rates varying from 10 ft down to 1 ft per hr, and for mixes having the various characteristics listed in Table I. The diagram clearly shows that the time element had no more than a secondary influence in determining the maximum pressures. With normal mixes, the maximum pressure for the rate of 10 ft per hr was reached in 42 min after the first foot had been placed; for the rates of 2 ft and 1 ft per hr, the maximum was obtained 2 hr after the first foot had been placed. The effect of a rich mortar is also indicated by this diagram. The pressure was greatly increased and in addition, as would be expected, the period of time during which the pressure continued to increase was considerably lengthened.

To complete these data two additional sets of tests are needed: one to include extremely dry mixes and the use of the internal vibrator, the other to show the effect of having the concrete and outside air quite cold, say from 35 to 40 F. The results already obtained indicate that these cold weather tests will develop somewhat greater pressures than those recorded in my tests. It is hoped that the conclusions here presented will arouse the interest of those who are in a position to conduct the additional tests.

This opportunity is taken to make grateful acknowledgment of the assistance given by F. R. McMillan, M. Am. Soc. C.E., Director of Research, Portland Cement Association, who has supplied a very complete bibliography on the subject of concrete pressure on forms. Acknowledgment for help in building the test apparatus and running the tests is also made to the following men, in the Louisville office of the Byllesby Engineering and Management Corporation: Messrs. George R. Armstrong, C. P. Watson, L. W. Pickel, and H. H. Heck.

Planning During a Depression

The Present Inadequacy of City and County Planning

By RUSSELL VAN NEST BLACK
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CITY PLANNER, NEW HOPE, PA.

PERHAPS no branch of the engineering profession has suffered as much during the depression as has that of city and regional planning. Today plans are more important than ever before because of the great number of public works projects which need coordination. However, the rôle of planning has been so consistently ignored for the past few years that there are no adequate plans for the work in hand. This article has been prepared from a paper, which was read by Mr. Black on January 17, 1935, before a session of the City Planning Division of the Society which was held in New York, N.Y., at the time of the Annual Meeting.

PLANNING need not and should not be shelved during a depression. However, this is exactly what has been done, if the procedure of the past five years may be taken as a criterion. The current flurry in state and national planning tends to obscure the present sad status of city and county planning. I believe that out of Federal-stimulated state planning activity there will ultimately develop an interest in and acceptance of planning procedure and plan making as essential functions of local government. That stimulus, however, has not yet become operative. When a local response to Federal and state stimuli comes it probably will be as a phenomenon of recovery rather than as a corollary of depression. The true picture of the effect of the depression on local planning activity is now before us, a mere ghost of the all too inadequate and yet thriving figure of planning as it stood in the decade, 1920 to 1930.

To those of us who know sound planning to be first and foremost an economy measure, it is not easy to explain the fact that, generally speaking, planning was one of the first victims of budget cutting under the pressure of reduced public income. The more obvious explanations of this fact are not entirely satisfactory, but beyond the obvious there can be only conjecture. Planning, as applied to governmental procedure, is not generally understood. This misunderstanding arises in considerable part from the fact that planning is usually either "oversold" or "undersold" and consequently appears to hard-pressed administrators as being either not worth its small cost or as involving costly improvements out of reach of an economy budget. (For the moment, I am assuming that all administrators primarily are interested in good government and in providing the maximum of public service per dollar expended.)

PUBLIC MISCONCEPTION OF PLANNING

Underselling either produces a weak reaction, insufficient to overcome the inertia of public feeling for traditional procedure, or gives the impression that planning is a kind of ornamental grillwork on the public structure—something that is all right when funds are plentiful, but something that a community may well do without. Overselling inflates planning to the status of a panacea for all urban ills and measures progress in the field by the extent and cost of artificially stimulated public improvements. Of these two pitfalls, overselling seems the more dangerous and probably is, in the larger part, to blame for the widespread failure of planning to hold its own during the depression.

Fortunately, comparatively little overselling can be ascribed to conscious action or ulterior motive. Many of the most sincere proponents of planning, including engineers of excellent standing, have been the greatest offenders in overselling.

Even the friends of planning generally think of accomplishment in this field only in terms of sewers laid and bridges built. They are disastrously in error. Planning is a method of procedure; plans are guides for procedure. Planning is not promotion, and plans should not be used primarily as the instruments of promotion. Plans may demonstrate deficiencies and mistakes in the municipal structure and may indicate the need for correcting them. To this extent, admittedly, they may be promotional. But the existing evils were not caused by planning and plans. Their correction is a matter of municipal rather than plan accomplishment. The plan merely indicates how and in what order improvements shall be made. A plan must anticipate the future and be idealistic enough to provide for the conditions and requirements of an advanced stage of growth and development.

Planning and plans do not create the need for new facilities or render them more desirable, but they do indicate where and how improvements can be placed to best advantage when and if they are required and can be afforded. Such planning is only the crystallization of ideas as to the requirements and possibilities of the future. It does not, in itself, change the status quo. A narrow street is in need of widening whether or not it is shown on a plan. Merely locating a new bridge on the plan does not increase the need for the structure, nor are the inadequacies of parks and playgrounds aggravated by a study of ways and means of enlarging such areas.

In other words, the carrying out of projects shown on a plan is less an indication of plan accomplishment than of community progress. The success of planning and plans is much more to be measured by the extent to which they are observed in the programming and executing of projects than by the speed with which the plan itself is realized.

THE ENGINEER AND LONG-RANGE PLANNING

No one has greater difficulty in grasping this conception of planning than engineers and others engaged in construction and accustomed, through years of training and experience, to blueprint planning and blueprint plans. Their difficulty is not surprising. Long-range planning, necessarily of a more or less conditional nature, is to all but the exceptional few a unique procedure. Man has seldom bothered to plan, except when realization of his plan seemed imminent. With exceedingly rare exceptions, his plans and blueprints have been guides for immediate and direct action. Such plans

have the single objective of facilitating construction. A plan for a new town to be built as one project comes in much the same category as the plan and specifications for a new warehouse. However, a plan for a city, county, or state, subject to the usual processes of growth and development over a considerable period of time, is an entirely different matter. In the latter instance, planning is as much—or more—a kind of procedure as it is a producer of plans or a stimulus to the making of improvements.

What has all this to do with shelving planning during periods of economic stress? All through the pre-depression years when planning seemed to be making considerable headway, progress and accomplishment in the field were described in terms of new and costly improvements. It is the custom at many planning conferences, both state and national, to call upon delegates to tell of planning progress in their home cities and counties. Nine out of ten of these reports are confined principally to the listing of recent improvements, such as street widening and building projects. Reference to the printed volumes of these reports discloses the fact that it is seldom shown how such projects are related to plan or if they have ever been included in plan. The reporters confuse community achievement with planning progress and accomplishment. Is it any wonder that many of the administrators and their public-minded supporters, who took planning seriously, fought shy of it when budgets were reduced and the municipal bond market failed?

MISUNDERSTANDINGS AFFECT PLANNING BUDGETS

There is every evidence that such a view of planning has had a strong influence upon the cutting of planning budgets. I was associated with one county planning board, the majority of whose members declined to ask for an appropriation for planning on the grounds that the county had no immediate prospects of making extensive capital improvements.

The St. Paul Real Estate Board addressed the following resolution, dated September 27, 1934, to the mayor and council:

> WHEREAS, The St. Paul Real Estate Board is of the opinion that major public improvements in St. Paul are completed in so far as it is practical to give further consideration to added development under present conditions, and
>
> WHEREAS, This situation does not justify the continuance of special appropriations for city planning purposes with tax delinquencies increasing at an unprecedented rate, and
>
> WHEREAS, The present financial condition of our city requires the practice of the most rigid economy in public expenditures, now therefore,
>
> *Be it Resolved*, That no funds be appropriated from the budget of the Commissioner of Public Works for the continuance of special assistance on city planning work and that the City Planning Board continue to function with the City Engineer as their chief technical adviser.

Here between the lines may be seen a little of the cupidity of some of the more predatory members of the real estate profession but, at the same time, a move gambling upon the chance that the Mayor and Council of St. Paul had a sufficiently distorted conception of planning to be deceived by such a specious argument.

How deep rooted is this point of view, which I believe to be a serious and dangerous misconception of planning, is well illustrated by the remarks of an old engineer, long interested in planning and at one time a leader of the Society, at a conference on a large regional planning project. Several internationally known planners had been brought together to give their views as to the proper and effective procedure. Discussion naturally turned to theory; policy and principle were of great importance at the then early stage of the project. However, proceedings were interrupted by this old, much-respected engineer, who made the abrupt statement that, "It is time to stop theorizing and do something—build a sewer, a bridge, or a highway, anything tangible to show the people that planning is something more than putting things down on paper." He was right, and yet at the same time he was very wrong. He had been a highway engineer and a bridge builder. His attitude was understandable but not helpful in getting planning, as an economical procedure, across to the public or to public administrators.

PLANNING DURING THE DEPRESSION

Comprehension of the true function of planning was making excellent headway when the depression came. But planning had not gained sufficient headway to withstand the onslaught of so-called practical administrators and of the countless taxpayers' associations suffering from civic astigmatism, which came into existence between 1931 and 1934.

I do not know to what extent the cutting of planning appropriations has been due directly to demands for public economy made by taxpayers' associations and similar citizen groups. Since the usual attitude of such bodies, however, is that of far greater interest in net reduction in tax rate than in the wise use of the tax dollar, it seems probable that in most instances planning appropriations have escaped direct attack because of their relative insignificance. It follows that such cuts in appropriations have probably resulted more from the choice of administrators than from specific citizen demand. In the absence of positive public support, and lacking sufficient personal conviction as to the need for planning and seeing it as something that could be dropped with the least danger of serious counter-protest, many hard-pressed administrators have undoubtedly initiated planning-cuts. More than that, many administrators have assumed without evidence that the taxpayers will not stand for planning expenditures in times of enforced economy. This assumption is groundless. I, at least, know of no instance of serious public protest against a reasonable expenditure for planning purposes, in depression or out. So seldom does a planning item become a matter of contention that administrative fear of public criticism falls pretty much into the category of an excuse for directing funds into more agreeable channels.

Nevertheless, it is obvious that the proper working out of planning requires positive public support. Failure to protest planning expenditures is given a negative interpretation. Planning has lost much of its ground because citizens who are really interested in the subject have not been sufficiently articulate. Only rarely will public administrators advance their policies beyond the known desires of a considerable proportion of the influential electorate.

PRESENT NEED FOR PLANNING

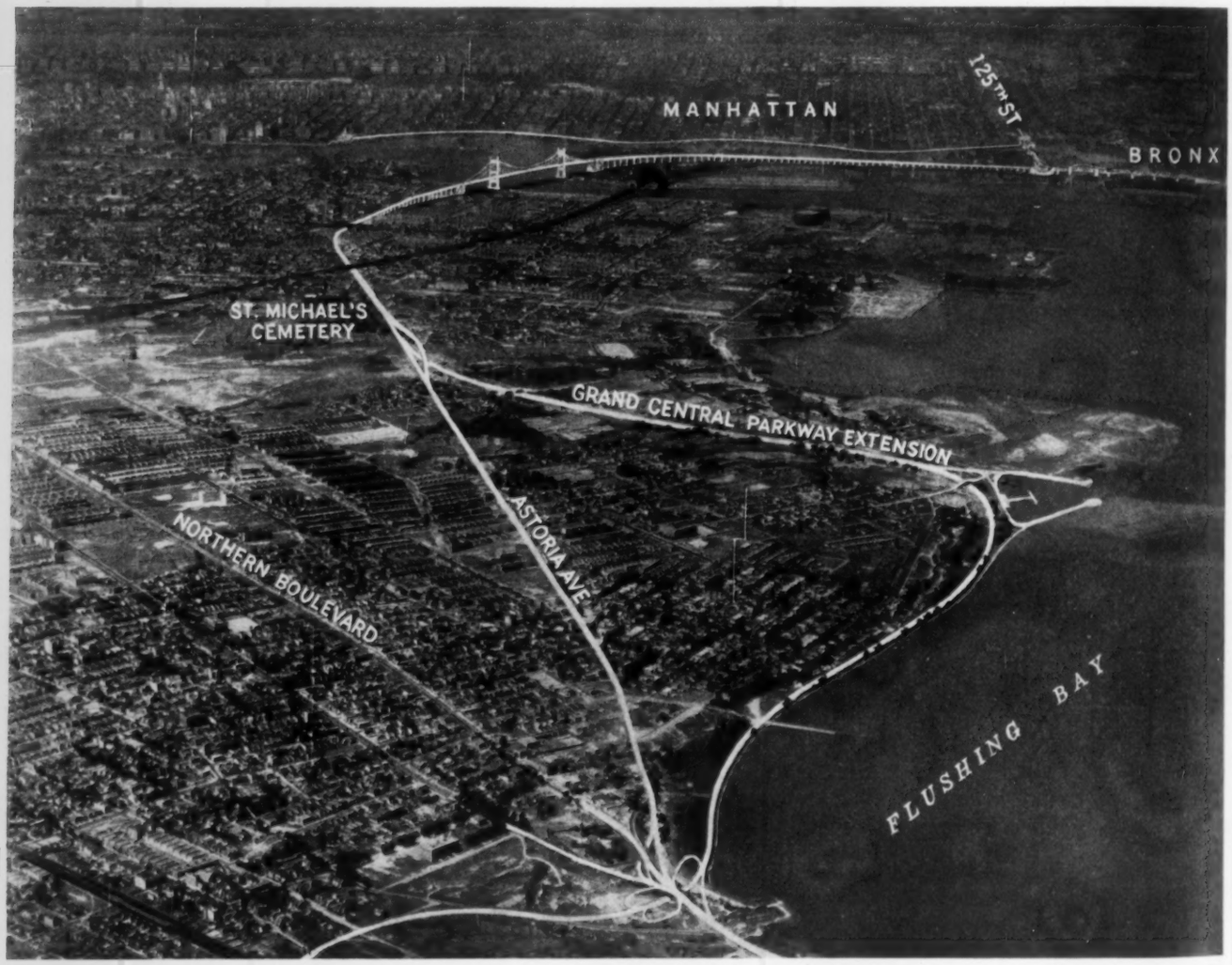
The present setback suffered by local planning has had more serious consequences than the mere loss of momentum. Never has there been greater need for planning and plans than during this period of made work and of expanded public works programs, directed toward the relief of unemployment and the priming of industry. From the very outset of these programs, public works administrators and project managers have demanded comprehensive plans for determining the relative merits

of projects and working plans for individual projects to facilitate a quick start upon construction. But there have been few plans and fewer planning organizations. In a spirit of false public economy engineering and planning staffs and departments had been disrupted. This public economy has paid the piper and is continuing to do so to the tune of many times the cost of maintenance of engineering and planning departments, in the shape of worthless, badly placed, and badly designed projects and in the refusal of Federal loans.

More people have been strongly impressed with the need for plan-preparedness during the past three or four years than ever before. However, most of them have spent their energies in bemoaning the lack of plans in the immediate emergency, assuming it to be too late to start or to resume planning. It was "too late" in 1932, 1933, and 1934, and the emergency is still with us and the need for plans is more pressing than ever. Needed plans actually could have been made a dozen times over during time already lost, and had they been started even when it was "too late" would now be in readiness to meet the responsibility of wise and effective execution of the greatly expanded public works program now proposed by the President for the year 1935–1936.

Any observer of the difficulties of the Federal Public Works Administration during the past year and a half, in disposing of a relatively small public works fund to useful purpose, will appreciate the problem and the dangers facing the PWA in this proposed new and larger effort. Generally speaking, the cities and counties of the United States are in no better position to enter upon an extensive program of public works construction expeditiously and with assurance of the soundness of projects than they were three years ago. Almost certainly, the unavoidable results of a large public works program sponsored by the Federal Government will be either: (1) the construction of many local projects of questionable merit and need; or (2) a large expansion of Federal public works, such as the improvement of rivers and harbors, into fields of relatively questionable economic and social justification; or (3) delay and consequent defeat of the chief purpose of the Federal administration, that of quick relief for the unemployed and the rapid stimulation of industry.

In my opinion this situation, with its unpleasant alternatives, may be laid entirely at the door of failure to plan intelligently and continuously in fair economic weather and in foul. Never was the adage "penny wise and pound foolish" more applicable than to the action of those misguided administrators who placed planning on the shelf during the depression.



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TRIBOROUGH BRIDGE, NEW YORK CITY, AND CONNECTIONS IN MANHATTAN, THE BRONX, AND QUEENS
Construction Progressing Rapidly with PWA Funds

Reports of Society Committees

Presented at the Annual Meeting of the Society in New York on January 16, 1935

Committee on Concrete and Reinforced Concrete Arches Renders Final Report

On authorization of the Board of Direction, the President of the Society appointed a Special Committee on Concrete and Reinforced Concrete Arches in May 1923. The members of the Society asked to serve on the committee were George E. Beggs, John R. Chamberlin, E. H. Harder, A. C. Janni, W. M. Wilson, and Clyde T. Morris. In December 1925 the committee lost one member, Mr. Chamberlin, by death. In the later years of its work, it secured the active cooperation of the U. S. Bureau of Public Roads, and E. F. Kelley and A. L. Gemeny sat with it in its deliberations.

Since the time of its appointment, the committee has been studying the design and construction of reinforced concrete arches, but there still remain many problems which it has not attempted to solve. Its work has been confined mainly to arch ribs and to arches with open spandrels. No work has been done on spandrel filled arches with the exception of determining the reaction components for skewed barrel arches, and there is still a large field of investigation open regarding the distribution of stresses and the effect of spandrel walls in this type of arch. The committee feels that its studies and investigations warrant certain conclusions, which are presented in its final report for the benefit of the profession.

There have been 12 major investigations sponsored by the committee. Eight of them have been in cooperation with the University of Illinois Engineering Experiment Station under the direction of Professor Wilson. A laboratory investigation of the time-yield of concrete underload was carried on for the committee by Raymond E. Davis, M. Am. Soc. C.E., at the University of California. Mr. Janni made a study of the effect of the elasticity of the piers upon the stresses in multiple span arches, and Mr. Beggs made an investigation of the reaction components in skew barrel arches.

The direct expenses of the investigations sponsored by the committee were paid from funds contributed largely by the Society, the U. S. Bureau of Public Roads, and the Engineering Foundation. Acknowledgments are also hereby made to the many other organizations and individuals who have contributed funds and materials and otherwise rendered valuable assistance.

The committee had not been studying its problems long before it realized that much information of value could be gained by laboratory tests of arch bridges where the conditions could be controlled and the reactions and loads accurately weighed. At the solicitation of the committee, the University of Illinois Engineering Experiment Station agreed to allow Professor Wilson to devote the major part of his time to this investigation and to provide space for the tests in the materials testing laboratory there. The investigations undertaken were:

1. Tests of single-span arch ribs.
2. Tests of single-span arches with spandrel columns and deck.
3. Tests of three-span arch ribs on slender piers.
4. Tests of three-span arch bridges with spandrel columns and decks on slender piers.
5. Tests to determine the effect of time-yield in concrete on the deformation stresses in a reinforced concrete arch bridge.

Chapter I of the final report, containing the conclusions and recommendations of the committee, has been preprinted and is available for distribution on request to the Headquarters of the Society. The report in detail was presented at the session of the Structural Division on January 17, 1935, at the Annual Meeting of the Society, and will appear in Volume 100 of Transactions, to be published in the autumn of 1935.

Respectfully submitted,
Clyde T. Morris, *Chairman*

First Annual Report of Special Committee on Hydraulic Research

In April 1934, when the Special Committee on Hydraulic Research was appointed by Harrison P. Eddy, then President of the Society, the following duties were outlined for it:

1. To determine upon a standardized system of symbols and nomenclature, for the use of all those carrying on model investigations in hydraulics.
2. To advise those carrying on model investigations in various hydraulic laboratories, bearing in mind the value of checking model work against full-size structures.
3. To encourage the preparation of papers relating to hydraulic research by those who are making investigations, and to find adequate and suitable means of publishing such papers.

In order to carry out this program three subcommittees have been appointed. The Subcommittee on Glossary and Symbols has as its purpose the standardization of symbols used in connection with hydraulic model studies and the compilation of a glossary of terms used in that work. It is composed of three members: L. G. Straub, chairman, Herbert D. Vogel, and Chilton A. Wright.

The Subcommittee on Conformity of Model to Prototype Performance purposes: (1) to assemble data with a view to determining conclusively the relative value of model tests and to define the physical limitations that must be observed in model studies; (2) to encourage performance tests of structures built as a result of model studies; and (3) to encourage model studies of existing structures whose behavior can be tested. Its membership consists of E. W. Lane, chairman, C. E. Bardsley, and Herbert D. Vogel.

The third subcommittee, that on Problems for Research, has two chief objectives: to compile a list of practical research problems that can be given out to students seeking thesis subjects and to others having facilities for undertaking such studies and a desire to do so; and to advise with universities and institutions when so requested in order to coordinate research, avoid unnecessary duplication, and keep problems on a practical basis.

The members of this subcommittee are Herbert D. Vogel, chairman, C. E. Bardsley, and L. G. Straub.

In addition to these activities, steps are being taken to prepare a concise report on the present status of hydraulic laboratory practice. The value of such a work is apparent, for considerable advance has been made since the publication of that comprehensive volume on *Modern Laboratory Practice*, compiled by the late John R. Freeman, Honorary Member and Past-President Am. Soc. C.E. This work is now under way and it is hoped that definite results will be available for publication in the near future.

The committee has decided to devote its major activities to open-channel work; flow in closed conduits will be included only when it is necessary as an adjunct to this investigation. The study of siphons, bends, and expanding and contracting pipes is therefore not excluded from the scope of the committee's activities, but the mechanical field involving pumps, turbines, draft tubes, and water hammer will be left to other agencies for the present.

Respectfully submitted,
J. C. STEVENS, *Chairman*
HERBERT D. VOGEL, *Secretary*

CLARENCE E. BARDSLEY L. G. STRAUB
E. W. LANE CHILTON A. WRIGHT

COMMITTEE ON EARTHS AND FOUNDATIONS

WITH THE SUPPORT of the Engineering Foundation, the Committee on Earths and Foundations has been undertaking various researches in order to make available to engineers the newly discovered principles of soil mechanics. These researches have been conducted in various places, including the laboratories of the following universities: Massachusetts Institute of Technology, Harvard, Yale, Columbia, and Minnesota. Research has also been carried out in Vienna. The investigations will be continued in 1935 and in subsequent years. Recently the study of earth dams has been added to the committee's work.

The following members of the Society constitute the personnel of the committee: George E. Beggs, M. L. Enger, R. J. Fogg, Glennon Gilboy, Harry T. Immerman, D. P. Krynine, F. A. Marston, George Paaswell, Charles Terzaghi, and Lazarus White, chairman.

The committee's progress report, published in PROCEEDINGS for May 1933, has been ably discussed by the members of the Society and has received favorable comment from other sources. The importance of the committee's work has been well stated by the Science Advisory Board, one of the most important bodies in this country, as follows:

"Within recent years there has been started a new branch of applied physics—soil mechanics—whose purpose is the accurate calculation of the behavior of soil when subjected to mechanical stresses. This behavior is calculated from the knowledge of certain physical constants such as compressibility, shearing modulus, porosity, water content, etc., which must be found by laboratory experiment for each type of soil under consideration.

"This theory has thrown new light—and in some cases indicates the advisability of revolutionary changes of engineering practice—on the best design of the foundations of all types of structures and on the behavior of cuts and fills in highways or other earth works such as excavations, canals, mines, reservoirs, dams, etc., especially as regards settling and sliding. The theory has thus far been given but one exhaustive test, which was done under the auspices of the American Society of Civil Engineers, and which was strikingly successful."

This is the justification the committee has for its work, for the appropriations of the Society, and for the efforts of the various members who have volunteered their services.

Respectfully submitted,
LAZARUS WHITE, *Chairman*

COMMITTEE ON FLOOD PROTECTION DATA RENDERS INITIAL REPORT

EFFORTS of the Society to stimulate interest in systematically collecting and listing flood data had their inception in 1922 at the time of the Spring Meeting held in Dayton, Ohio, April 5–7, which was devoted entirely to the subject of floods and flood control. As a result the Board of Direction appointed a Special Committee on Flood Protection Data headed by N. C. Grover, M. Am. Soc. C.E. After a five-year study by this committee and a continued but fruitless effort on the part of the Society to have included in the Federal budget sufficient funds for the U. S. Geological Survey to carry on this work, the magnitude of which was beyond the resources of the Society to undertake, the special committee was disbanded in 1928.

Subsequent events revived interest in flood data. In 1928 Congress ordered an extensive survey and report on 200 rivers of the United States, known as the "308 reports," in which much consideration was given to flood control problems. In increasing damage toll by great floods in all sections of the country led to the demand for action. In 1934, the Mississippi Valley Committee was appointed to report to the Public Works Administration on an analysis of flood, rainfall, and run-off data. The Society was requested by the Mississippi Valley Committee to appoint a new Committee on Flood Protection Data to assist it in an advisory capacity in connection with the compilation and analyses of flood data. This committee consists of the following members of the Society: Gerard H. Matthes, chairman; Robert E. Horton, Ivan E. Houk, Charles W. Kutz, Charles W. Sherman, and Daniel C. Walser. It began activities in May 1934 and held its first meeting the following August.

When in October 1934 the National Resources Board took over the work of the Mississippi Valley Committee, the compilation of flood data was extended to cover all the streams of the United States, and the Committee on Flood Protection Data became advisory to the Director of the Water Resources Section of the National Resources Board, to whom it has already reported its views.

In its progress report to the Society, which is to appear in full in the March issue of PROCEEDINGS, where it should receive the attention and discussion of interested members, the committee urges the importance of obtaining, compiling, and making available in published form flood data on all streams. In the matter of frequency analyses, it holds that the choice of method should be governed by the nature of the problem to be dealt with, and therefore should be left to the decision of the practicing engineer who uses the data. It recommends further that the coordination of all gaging operations, and maintenance of gage records, now handled by the several governmental bureaus, be coordinated under one Federal agency, which would have charge of the analysis and publication of all hydrologic data.

Mapping for National Planning

Abstract of Paper Presented Before the Surveying and Mapping Division on January 16, 1935

By FREDERICK H. MCDONALD

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, ATLANTA, GA.

UNDER the leadership of the national administration, planning is apparently on the way to becoming an accepted basis for procedure in national and local government. The great advantages in economy and in the economic use of natural resources that result from the "considered use" of today's efforts in the light of future requirements become obvious.

The greater the assumption of responsibility for national progress by the Federal Government, the greater the need of those in government positions for the type of basic information that originates with and can be found only on carefully made base maps of our local areas and regions. It is unfortunate that each governmental and business agency, requiring maps and finding them not available, has had to undertake to create its own mapping organization, make its own surveys, and produce its own maps. Overlapping, duplication, and much needless expenditure of money characterize this method of procedure.

WHAT IS A BASE MAP?

A base, standard, or key map of a region or a country is one that shows to the most precise degree of practicable accuracy the horizontal, dimensional relationship of all the fixed features on the earth's surface, and their relative elevations referred to a fixed plane generally taken as sea level. The strength and value of such a base map lie in the completeness and the dependability of the information shown on it. Such maps require a type of initial accuracy that will practically dispose of subsequent reasons for corrections of distances or elevations. A base survey is located astronomically by stellar observations, and though its controlling points may vanish or be destroyed, their geographic position is a matter of precise, indestructible knowledge, and the points can be replaced.

THE STATUS OF MAPPING IN THE UNITED STATES

In theory, the need for accurate maps has been recognized in the United States for several decades, and certain Federal agencies have been engaged at very inadequate rates of progress on the production of a standard map of the United States. However, a standard map is not yet available. It is commonly estimated that only about 45 per cent of the interior of the country has been covered by topographic surveys and that, of that 45 per cent, about half of the surveys, made 40 or 50 years ago, were originally of the reconnaissance type and of such a character that they are now entirely inadequate or out of date.

This means that only about 25 per cent of the country is accurately mapped, and that 75 per cent of it still must be surveyed to provide an accurate and reliable base map of the United States. The special information and commercial maps that are available are simply two-dimension maps, picturing relative but only approximate directions and distances. They lack accuracy and are of only approximate value, showing nothing of ground features and little of what is on the ground.

In response to a report made by the National Academy of Science, Congress created the U. S. Geological Survey in 1879. To function properly as a scientific fact-finder, the Geological Survey realized that a topographic base map that would accurately delineate physiographic and cultural details was a necessity. Accordingly, a plan to map the entire United States systematically was formulated and adopted. This resulted in the present topographic sheets, which have had a demand in excess of a million copies in recent years even though in many cases they are out of date and inadequate.

The U. S. Coast and Geodetic Survey is the sole Federal agency charged with establishing a control network throughout the United States. All other agencies now procure their initial control from the Survey. The control, or base triangulation of the United States, is computed on the surface known as the "Clarke Spheroid of 1866," and all geodetic positions are derived from that of a single station, namely, "Meade's Ranch" in Kansas, the adopted position of which on the Clarke Spheroid fixes the geodetic datum. The governments of Canada and Mexico have agreed to employ this same datum for their triangulation, and since 1913 it has been called the North American Datum. It ensures a single, unified network of control for the entire North American continent.

EXISTING FEDERAL PROGRAM

The topographic surveys made by the U. S. Geological Survey and the resulting maps are now dependent upon funds provided jointly through Federal and state appropriations. In the last ten years, however, only about $4,000,000 has been received from states for cooperative mapping. The inadequacy of such procedure is evident, and the Federal Government, necessarily, must assume the function of completing its own base map with Federal funds.

On February 2, 1925, Congress passed the Temple Act. This act authorized the President to complete the topographic map, including the necessary horizontal and vertical control, within a period of twenty years, and authorized the appropriations necessary for that purpose. From 1926 to 1932 the average appropriation for both control surveys and for mapping amounted to $765,000 per year. Now, ten years after the passage of this bill, the inadequacy of the funds actually made available can be visualized by considering the report of the Federal Board of Surveys and Maps, which recommends an average appropriation of $12,000,000 a year for the next ten years, based on estimated costs of $117,531,000 for completing the base map. This plan, released on January 14, 1935, by the National Resources Board, was published in detail in the February issue of CIVIL ENGINEERING.

For years the engineers of the country and those interested in the making of maps have realized the wastefulness and ineffectiveness of the present haphazard and miscellaneous efforts of numerous governmental departments to make their own surveys and maps. There is

now being crystallized a sentiment for the centralization of these agencies, and it is hoped that this may be achieved by executive order before the expiration of the present Congress. The economies resulting from the elimination of overhead and the discontinuance of wasteful duplication of mapping are evident.

CHARACTERISTICS REQUIRED FOR A NATIONAL PROGRAM

Any conception of an efficient and economical method of handling not only the present emergency mapping situation, but also the long-range program of Federal surveying and mapping, should include the following:

1. A new centralized surveying and mapping agency or board should be created as a consolidation of existing surveying and mapping agencies. The function of such a mapping bureau would be to execute and provide all the base mapping requirements of the nation.
2. Periodically, the various Federal agencies should report their surveying and mapping requirements.
3. The mapping bureau should study these reports and arrange a program to be executed within whatever time limit their importance may justify.
4. Priority as to time of work and locality should be worked out in connection with the requirements of the several agencies served, but the standards of the work done should be such that each product automatically becomes a part of the standard map.
5. Air-photography should be used wherever practicable.
6. The geodetic control should be completed and adjusted as quickly as possible, in order that it may be available for any project.
7. Certain projects will be of such character as to require separate individual treatment by the agencies affected, but these projects also can contribute material for the standard map. Thus it should be required that they be tied into the geodetic control nets.
8. Certain Federal agencies would use the standard map, or material from it, as a base on which to show special information pertinent to their respective functions. The big saving to be expected comes from a general reduction of overhead and from the reductions in the cost of duplicated field work.

FEASIBILITY AND REQUIREMENTS OF A LARGE MAPPING PROGRAM

A project for mapping the country in from 10 to 12 years is a large one, but not otherwise difficult. Mapping is a relatively simple engineering operation. There must be a nucleus of thoroughly trained engineers who understand the finer points of the work. However, such a nucleus already exists, and a large mapping organization can be built around it. Steps to be taken in the execution of such a program follow:

1. There should be a reorganization of the Federal mapping agencies.
2. A careful study should be made of the kind of map to be produced.
3. Funds should be secured for undertaking the work. The first step in the field work would be to spread networks of triangulation, traverse, and levels over the areas to be mapped. As soon as this work is under way the areas should be photographed from the air.
4. With these photographs and the results of the triangulation, traverse, and leveling surveys, large numbers of engineers can be employed in offices compiling planimetric maps, that is, maps without elevations.
5. Before the work can be considered completed, elevations must be shown by means of contours. As the two-dimension work sheets become available, the task of providing contouring should be undertaken.
6. The final drawing and publication of the results on the various standard scales necessary for convenient use by the public should be undertaken as soon as the contouring and topographic detail are completed.

Whether or not there is created a central bureau of surveying and mapping, to provide an able, disinterested, and responsible means of communication between the mapping agency, or agencies, and the users of maps, both business and governmental, there is need for a board of competent, technically equipped citizens of wide experience to act in an advisory capacity to the governmental mapping agency. Such a board could act as a judicial body to determine the various factors affecting mapping. It could also control the kinds of maps to be made, mapping standards, and the areas to be mapped at given periods. Such a board could be appointed by the proposed mapping agency itself or by the joint action of existing agencies in cooperation with various professional and technically representative groups.

ENGINEERING EDUCATION AND SURVEYING METHODS

As a corollary to a ten-year program of making national control networks and mapping, the adequacy of the type of instruction given those who will use these newly available data must be considered. With the completion of the proposed mapping program, every state will have a great number of permanent monuments, requiring probably not over a five-mile maximum survey to reach any particular one. While the production of accurate base maps from these control monuments is important, the future surveys for local development and for determining land boundaries are equally important. This prospect makes it necessary to consider the type of surveying instruction now available for engineering students. If permanent reference points are to be made the basis of a complete map of the properties in the country, future requirements will demand that every survey start and close on a first or second-order reference point for horizontal control, and on a precise bench mark for elevation control. To achieve this result it would be necessary that the curriculum of every educational institution teaching surveying include a definite and sufficient amount of instruction in precise surveying.

Until the standard base maps are complete, soil survey maps cannot be made fully available, and the agricultural opportunities of the nation are retarded. Only by having surveys of any property accurately made and tied into permanent reference monuments is it possible, indisputably and officially, to make easy and accurate relocations, and to make from these individual property surveys an accurate, mosaic, property map of the area, which can be used for tax purposes as well as for transfers of titles. The artillery in the U. S. Army would be useless for accurate indirect fire against an invading force, without the precise control and topographic data that can be afforded only by completed standard base maps. Topographic maps have proved to be an invaluable aid in the study and teaching of physical geography, both in the public schools and in the colleges. Areas of plant quarantine, which have been established to protect the agricultural resources of the country and the well-being of the whole people, can be shown. Also, bioclimatic areas can be readily outlined on topographic base maps without extensive field surveys.

Every department of the Federal Government has had occasion, and will continue to have occasion, to demand accurate, topographic maps. The structure of outcropping rocks must be studied in relation to the shape and elevation of the land surface, and such features are readily obtainable only from good maps. For the control of malaria and for studies of stream pollution and water resources, good topographic maps are essential. It has been said that enough money has been wasted in faulty highway construction due to inaccurate information to more than provide for the full cost of the completion of the base map of the United States. Because of

insufficient information on watersheds, the flow of water has had to be assumed. This has resulted in periodic, expensive, and dangerous washouts as well as the frequent over-design of structures, which has caused wasteful expenditure. All the factors influencing the sound location of industrial enterprises, including plant site, topography, water supply, drainage, highway and railroad transportation, power lines, and the relation of urban and rural areas as a source of labor supply, can be determined from topographic maps without detailed local surveys.

It has been stated that, through lack of maps, the oil industry alone has been losing on an average each year more than the total cost of making topographic maps for the oil-producing states. For the first time in the history of our country, the recent national census revealed a population preponderantly urban. This tendency brings with it such problems of future planning that nearly all the large communities in the country are becoming planning-conscious. Only with topographic maps can the details of community expansion be worked out effectively and with economy. Automobile tourists make extensive use of topographic maps, because no other maps in existence supply the motorist with so many valuable details. Public utilities generally make their own surveys—in many cases inadequate ones—because of the necessity for speed. Not only could the expenditure of considerable money be avoided if accurate base maps were available, but large expenditures for plant could be saved as a result of the more accurate design possible only when more accurate field information is available. Both of these costs enter into the rate base structures of utilities and will continue to be added until a base map becomes available. This means that every consumer of every utility continues to pay on this unnecessary investment.

NATIONAL MAPPING PLAN

It is logical to assume that the National Mapping Plan of the Board of Surveys and Maps will be used as a basis for any expenditures arising out of the appropriation of funds for such purposes by the Federal Government. In view of the great need for maps, the impetus to planning for future improvement throughout the nation, and the great benefits that can come from the intelligent use of accurate information, it behooves every engineer and every citizen to support the Government in working out such a program and in securing the continuing appropriation of funds necessary for its completion.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from engineers both young and old, should prove helpful in the solution of many troublesome problems.

The Double-Modulus Theory of Column Action

By WILLIAM R. OSGOOD, ASSOC. M. AM. SOC. C.E.

MATERIALS TESTING ENGINEER,
NATIONAL BUREAU OF STANDARDS, WASHINGTON, D.C.

ALTHOUGH the double-modulus theory of column action is known by name to many engineers in this country, repeated inquiries from well-informed engineers requesting an exposition of the theory in English, together with the growing recognition of the theory, indicate that it should be made readily available to American engineers. The theory is useful to the engineer engaged in testing columns and to the designing engineer alike. It offers the former a means of interpreting rationally his test results, and the latter a picture of column action comparable in clarity to that of beam action. Therefore it seems to be worth while to present the theory.

What is here called the double-modulus theory has frequently been called also the Considère-Engesser theory and Kármán's theory. Many competent engineers are mistaken as to the origin of the theory, and a brief account of its development will not be out of place. In 1891 there was published a memoir included as an appendix (*annexe*) to the proceedings of the Congrès International des Procédés de Constructions, held in Paris from the 9th to the 14th of September 1889, in which A. Considère pointed out that, as an ideal column stressed beyond the proportional limit begins to bend, the stress on the concave side increases according to the law of the compressive stress-strain diagram, and the stress on the convex side decreases according to Hooke's law, and that therefore the strength would be given by

$$P = \pi^2 \bar{E} I / L^2,$$

in which $\bar{E}$ is a modulus, the value of which lies between the modulus of elasticity and the tangent modulus. Considère realized that $\bar{E}$ was a function of P/A, the average stress in the column, but did not go further than to point out this fact.

Earlier in 1889 Fr. Engesser presented his tangent-modulus theory, and in 1895 Félix Jasinski ("Noch ein Wort zu den Knickfragen," *Schweizerische Bauzeitung*, Vol. XXV, No. 25, page 172, June 22, 1895) pointed out that this theory was not correct and called attention to Considère's work. He stated that at that time it was impossible, however, to determine theoretically the form of the function $\bar{E}$. Thereupon Engesser, in "Ueber Knickfragen" *Schweizerische Bauzeitung*, Vol. XXVI, No. 4, page 24, July 27, 1895, acknowledged the error in his original theory and replied that the possibility of determining $\bar{E}$ theoretically was in no wise out of the question, and he determined it in the general form, which will be given in Equations 5 and 10. Nothing further was done apparently until Kármán ("Untersuchungen über Knickfestigkeit," by Theodor von Kármán, M. Am. Soc. C.E., *Forschungsarbeiten*, Nr. 81, 1910) pre-

sented the theory again, added the actual evaluation of $\overline{E}$ for the rectangular cross section and the idealized H-section (consisting of infinitely thin flanges and negligible web), and gave the theory new life by making a series of careful tests designed to afford a check on the theory. Since then $\overline{E}$ has been evaluated for other cross sections by a number of writers.

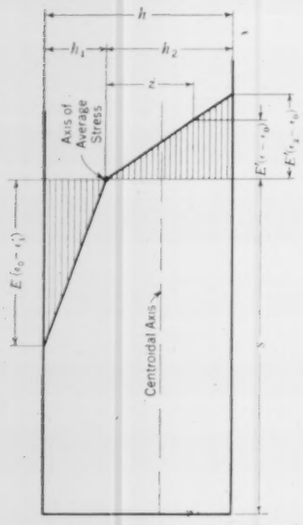


FIG. 1. DISTRIBUTION OF STRESS

The assumptions upon which the theory rests are as follows: (1) the column is straight and of uniform cross section, and the material is homogeneous; (2) the relation between longitudinal stress and longitudinal strain in any individual fiber is the same as that indicated by the compressive stress-strain diagram of the material; and (3) cross sections remain plane and normal to the center line of the column after bending.

Consider a column uniformly compressed by a force $P = As$ and then deflected slightly. As a consequence of the assumptions that have been made the following distribution of stress takes place. In every cross section there is a straight line, the axis of average stress, along which the stress s remains unchanged. On one side of this axis the stresses are increased by the bending, the rate of increase being proportional to the tangent modulus, E', of the compressive stress-strain curve at the stress s; on the other side the stresses are decreased, the rate of decrease being proportional to the modulus of elasticity of the material, since the deformations on this side are elastic. This distribution of stress is shown in Fig. 1. The strains are denoted as follows: the strain at the axis of average stress, by ϵ_0; the strain at any point of the cross section, at a distance of z from the axis of average stress, by ϵ, where z is measured positive toward the concave side of the column; the strain in the least compressed fiber, by ϵ_1; and the strain in the most compressed fiber, by ϵ_2.

At any cross section the moment of the stresses about the centroidal axis of the cross section normal to the plane of bending must equal the moment of the applied load about this axis. Since the moment of the average stresses, s, about the centroidal axis is zero, this condition may be expressed by

$$\int_{A_1} E\ (\epsilon - \epsilon_0)\ z dA + \int_{A_2} E'(\epsilon - \epsilon_0)\ z dA = Py \quad . \quad . \quad [1]$$

in which A_1 and A_2 are the parts of the cross-sectional area on the two sides of the axis of average stress which are subjected to a decrease and an increase of stress, respectively. A little consideration will show that the curvature is given by

$$\frac{d^2y}{dx^2} = -\frac{\epsilon - \epsilon_0}{z} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [2]$$

with the usual approximation made in the theory of flexure and with the distance between the axis of average stress and the centroidal axis considered negligible in comparison with the radius of curvature. Substituting $\epsilon - \epsilon_0$ from Equation 2 in Equation 1 gives

$$E\frac{d^2y}{dx^2}\int_{A_1} z^2 dA + E'\frac{d^2y}{dx^2}\int_{A_2} z^2 dA = -Py \quad . \quad . \quad [3]$$

The two integrals in Equation 3 are the moments of inertia of A_1 and A_2, respectively, with respect to the axis of average stress. Denote these moments of inertia by I_1 and I_2. Equation 3 then becomes

$$(EI_1 + E'I_2)\frac{d^2y}{dx^2} = -Py \quad . \quad . \quad . \quad . \quad . \quad [4]$$

or with

$$\overline{E} = \frac{EI_1 + E'I_2}{I} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [5]$$

$$\overline{E}I\frac{d^2y}{dx^2} = -Py \quad . \quad . \quad . \quad . \quad . \quad . \quad [6]$$

The integration of this equation gives for the case of a column with freely supported ends

$$P = \frac{\pi^2 \overline{E} I}{L^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [7]$$

In order to determine I_1 and I_2, and thus $\overline{E}$, it is necessary to locate the axis of average stress, which may be done as follows.

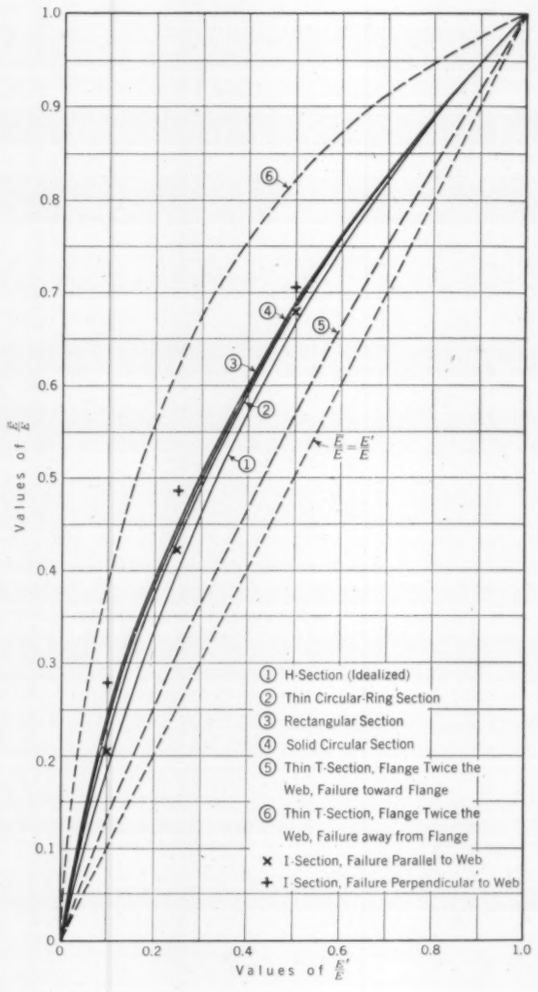

Values of $\frac{\overline{E}}{E}$
Values of $\frac{E'}{E}$
$\frac{\overline{E}}{E} = \frac{E'}{E}$
① H-Section (Idealized)
② Thin Circular-Ring Section
③ Rectangular Section
④ Solid Circular Section
⑤ Thin T-Section, Flange Twice the Web, Failure toward Flange
⑥ Thin T-Section, Flange Twice the Web, Failure away from Flange
× I-Section, Failure Parallel to Web
+ I-Section, Failure Perpendicular to Web

FIG. 2. VARIATION OF $\frac{\overline{E}}{E}$ WITH $\frac{E'}{E}$ FOR VARIOUS SHAPES OF CROSS SECTION

At any cross section the resultant of the distribution of stress must equal the applied load. Since s is the average stress, this condition may be expressed by

$$\int_{A_1} E\,(\epsilon - \epsilon_0)\,dA + \int_{A_2} E'\,(\epsilon - \epsilon_0)\,dA = 0 \quad . \quad [8]$$

By substituting $\epsilon - \epsilon_0$ from Equation 2, we obtain

$$E\,\frac{d^2y}{dx^2}\int_{A_1} z\,dA + E'\,\frac{d^2y}{dx^2}\int_{A_2} z\,dA = 0 \quad . \quad [9]$$

The two integrals in Equation 9 are, respectively, the negative of the statical moment of A_1 and the statical moment of A_2 with respect to the axis of average stress. If these statical moments are denoted by S_1 and S_2, respectively, Equation 9 may be written

$$ES_1 = E'S_2 \quad . \quad [10]$$

Equation 10 serves to locate the axis of average stress at any average stress, s, at which the tangent modulus is E'. When this is done, the values of I_1 and I_2 can be computed, and $\overline{E}$ appears as a function of E and E'. Thus for the rectangular cross section of width b and depth $h = h_1 + h_2$ in the plane of bending (see Fig. 1), Equation 10 gives

$$\tfrac{1}{2}\,bh_1^2\,E = \tfrac{1}{2}\,bh_2^2E' \quad . \quad [11]$$

or

$$\frac{h_1}{h_2} = \sqrt{\frac{E'}{E}} \quad . \quad [12]$$

Equation 5 becomes

$$\overline{E} = \frac{\frac{1}{3}\,bh_1^3E + \frac{1}{3}\,bh_2^3E'}{\frac{1}{12}\,b(h_1 + h_2)^3} \quad . \quad [13]$$

which may be written

$$\frac{\overline{E}}{E} = \frac{4\left(\frac{h_1^3}{h_2^3} + \frac{E'}{E}\right)}{\left(\frac{h_1}{h_2} + 1\right)^3} \quad . \quad [14]$$

Substituting $\frac{h_1}{h_2}$ from Equation 12 in Equation 14 gives the final form

$$\frac{\overline{E}}{E} = \frac{4\,\frac{E'}{E}}{\left(1 + \sqrt{\frac{E'}{E}}\right)^2} \quad . \quad [15]$$

The variation of $\overline{E}/E$ with E'/E as determined by various investigators for a number of different cross sections, is shown in Fig. 2 ("Column Curves and Stress-Strain Diagrams," by William R. Osgood, Assoc. M. Am. Soc. C.E., Bureau of Standards *Journal of Research, Research Paper No. 492*, Vol. 9, page 571, October 1932). It will be noted that the H-section is the weakest of the symmetrical sections given in Fig. 2, since for a given value of E'—that is, s—the value of $\overline{E}$ is less than for any other of the symmetrical sections. It can be shown that the H-section is, in fact, the weakest of all possible symmetrical cross sections.

It is significant that $\overline{E}$ is a function not only of the average stress but also of the shape of the cross section. Some anomalous types of column failure ("Tests of Large Columns with H-Shaped Sections," by L. B. Tuckerman and A. H. Stang, *Technologic Papers of the Bureau of Standards, No. 328*, October 20, 1926) in which bending begins about the second principal axis of inertia of the cross section and then proceeds about the first principal axis can be explained on the basis of this relation. No other explanation has been found.

Unsymmetrical Vertical Curves

By E. L. PAVLO

ASSISTANT ENGINEER, MADIGAN AND HYLAND, ENGINEERS, NEW YORK, N.Y.

THE transition from one grade to another in highway design is usually accomplished by means of a parabolic curve. The common practice is to make the vertical curve symmetrical with respect to the point of intersection of the grades, that is, with the horizontal projections of the tangents equal. When the curve happens to be over a bridge, as is often the case in grade crossings, it is necessary sometimes to fix the grade elevation at the mid-span or other points to satisfy clearance requirements. In case the grades are already established, the connecting vertical curve is often unsymmetrical. In earthwork, in case it is desired to follow an existing profile closely to limit the amount of cut or fill, this can usually be accomplished best by the use of an unsymmetrical vertical curve. In general, the imposition of any special requirements will result in an unsymmetrical curve.

The derivation of general formulas for such curves follows.

For example, assume that the grades g_1 and g_2, the point of curve, and the point of intersection of the grades are given (Fig. 1). The problem is to pass a parabolic curve through the point b. Let $abcd$ be the required curve and c the point of highest elevation. The equation of the parabola, referred to the origin at a, will be,

$$y_1 = g_1x_1\left(1 - \frac{x_1}{2l}\right) \quad . \quad [1]$$

and the equation of the parabola, referred to the origin

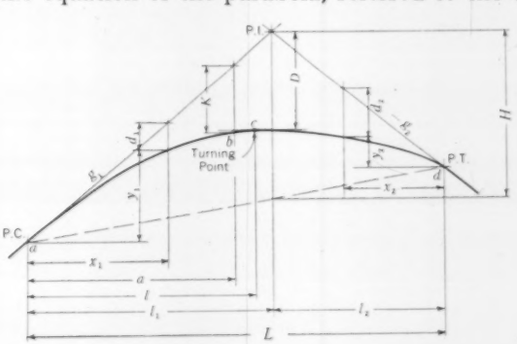


FIG. 1. AN UNSYMMETRICAL VERTICAL CURVE

at d, will be

$$y_2 = g_2x_2\left[\frac{x_2}{2(L-l)} - 1\right] \quad . \quad [2]$$

The offset, d_1, can then be written,

$$d_1 = g_1x_1 - y_1 = g_1x_1 - g_1x_1\left(1 - \frac{x_1}{2l}\right) = g_1\frac{x_1^2}{2l} \quad . \quad [3]$$

Similarly, the offset d_2 may be expressed as,

$$d_2 = -g_2\frac{x_2^2}{2(L-l)} \quad . \quad [4]$$

From Equations 3 and 4 it may be seen that the offsets, d_1 and d_2, are proportional to the squares of their respective distances. Therefore we may write:

$$D = \frac{kl_1^2}{a^2} \quad \ldots \quad [5]$$

$$d_1 = \frac{Dx_1^2}{l_1^2} \quad \ldots \quad [6]$$

$$d_2 = \frac{Dx_2^2}{l_2^2} \quad \ldots \quad [7]$$

Writing y_1 equal to $g_1x_1 - d_1$, and y_2 equal to $-g_2x_2 - d_2$ and substituting for d_1 and d_2 as given in Equations 6 and 7,

$$y_1 = g_1x_1 - \frac{x_1^2}{l_1^2}D \quad \ldots \quad [1a]$$

$$y_2 = -g_2x_2 - \frac{x_2^2}{l_2^2}D \quad \ldots \quad [2a]$$

Since the curve *abcd* is continuous, $\frac{dy_1}{dx_1}$ where x_1 equals l_1 should be equal to $\frac{dy_2}{dx_2}$ where x_2 equals l_2, or by differentiating Equations 1*a* and 2*a* and equating,

$$g_1 - \frac{2D}{l_1} = g_2 + \frac{2D}{l_2} \quad \ldots \quad [8]$$

Solving for D,

$$D = \frac{l_1l_2}{2(l_1 + l_2)}(g_1 - g_2) \quad \ldots \quad [9]$$

Equation 9 represents a very useful relation between the various elements in the design of vertical curves. By changing the values of some of the terms of the equation their effect upon the others may be readily determined.

The distance, D, can also be proved equal to one-half the perpendicular dropped from *P.I.* on to the long chord, *ad*.

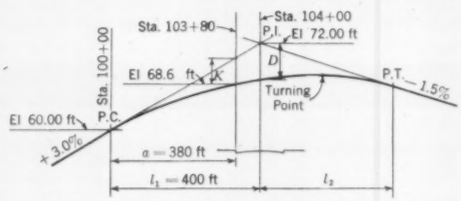


FIG. 2. METHOD OF SOLUTION APPLIED TO AN OVERHEAD CROSSING

From Fig. 1, by geometrical reasoning, we may write,

$$\frac{H}{2} = \frac{1}{2}\left[g_1l_1 - (g_1l_1 + g_2l_2)\left(\frac{l_1}{l_1 + l_2}\right)\right] = \frac{l_1l_2}{2(l_1 + l_2)}(g_1 - g_2)$$

Therefore $\frac{H}{2} = D$. $\quad \ldots \quad [10]$

This relation may be useful in preliminary graphic solutions or may serve as a check on computations. Equations 1*a*, 2*a*, 9, and 10 are for vertical curves in general and therefore are applicable to the case of symmetrical curves as well. For that case l_1 equals l_2, and Equation 9 becomes

$$D = \frac{l_1}{4}(g_1 - g_2) \quad \ldots \quad [9a]$$

$$= \frac{L}{8}(g_1 - g_2)$$

In case the grades are of the opposite sign, the curve has a turning point. To locate the turning point, differentiate Equation 1*a* or 2*a*, take dy/dx equal to zero when x equals l, and solve for l, getting

$$l = \frac{g_1l_1^2}{2D} \quad \ldots \quad [11]$$

and $$l = -\frac{g_2l_2^2}{2D} \quad \ldots \quad [12]$$

Equation 11 should be used when the turning point occurs between the point of curve and the point of intersection of the grades, l being measured from the point of curve. Equation 12 should be used when the turning point occurs between the point of intersection and the point of tangency, l being measured from the point of tangency.

From Equations 11 and 12 it may be observed that the turning point occurs to the left of the point of intersection if $2D/g_1$ is more than l_1 and, to the right of it, if $-2D/g_2$ is more than l_2. When the turning point occurs directly under the point of intersection, l, is equal to l_1,2 and Equations 11 and 12, solved for D, become

$$D = \frac{g_1l_1}{2} \quad \ldots \quad [13]$$

$$D = -\frac{g_2l_2}{2} \quad \ldots \quad [14]$$

The equations presented here are sufficient for the solution of any problem in the design of vertical curves. The following example will illustrate the method.

AN EXAMPLE SOLVED

The grades, g_1 and g_2 are given as +3.00 per cent, and −1.50 per cent, respectively.

The point of curve is at Station 100 + 00 and elevation + 60.00 and the point of intersection of grades is at Station 104 + 00 (Fig. 2).

The problem is to pass a curve through elevation 68.62 at Station 103 + 80 to satisfy the clearance requirement at the curb of the underpass.

By reference to Fig. 2,

$$k = 60.00 + 3.80 \times 0.03 - 68.69 = 2.71$$

From Equation 5,

$$D = \frac{kl_1^2}{a^2} = \frac{2.71 \times 4^2}{3.8^2} = 3.0 \text{ ft}$$

From Equation 9,

$$D = \frac{l_1l_2}{2(l_1 + l_2)}(g_1 - g_2)$$

$$\text{and } 3.0 = \frac{4l_2}{2(4 + 1_2)}(0.03 + 0.015)$$

Solving, l_2 equals 200 ft; the point of tangency is at Station 106 + 00; the elevation of the point of intersection is 60 + 3 × 4, or 72.00 ft; and the elevation at the point of tangency is 72 − 1.5 × 2, or 69.00 ft.

To find the grade elevations use Equations 1*a* and 2*a*. From Equation 12 the high point of the curve occurs at,

$$l = \frac{-g_2l_2^2}{2D} = \frac{1.5 \times 2^2}{2 \times 3} = 100 \text{ ft from the point of tangency.}$$

The Aeration of Sharp-Crested Weirs

By JOE W. JOHNSON

U. S. WATERWAYS EXPERIMENT STATION, VICKSBURG, MISS.

THREE problems are involved in the aeration of weirs in which the end contractions have been suppressed: (1) the effect of a reduction in pressure under the nappe on the observed head-quantity relationship or on the weir coefficient; (2) the quantity of air which can be removed by the nappe and the effect of backflow of air bubbles; and (3) the required size of air inlets to replace the air withdrawn by the nappe.

In the Hydraulics Laboratory of the University of California experiments were performed on a sharp-crested weir so constructed that the quantity of air supplied to the underside of the nappe could be measured by observing the pressure drop through a capillary tube. The pressure under the nappe for different conditions of rarefaction was measured by a precision tilting manometer.

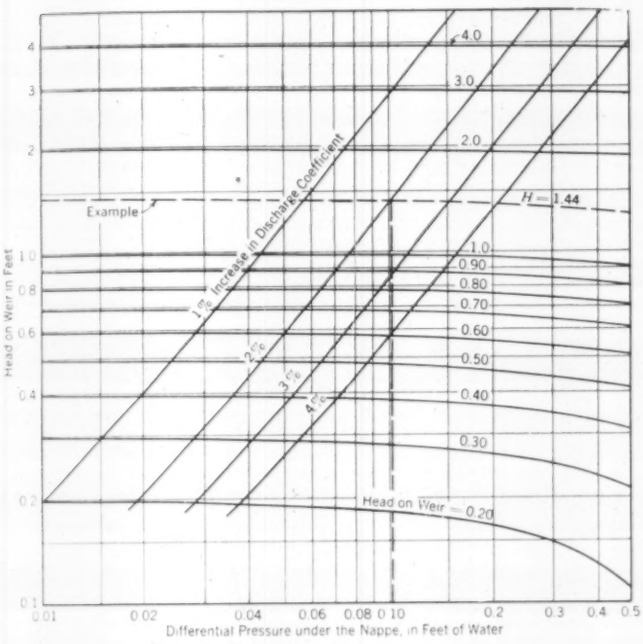
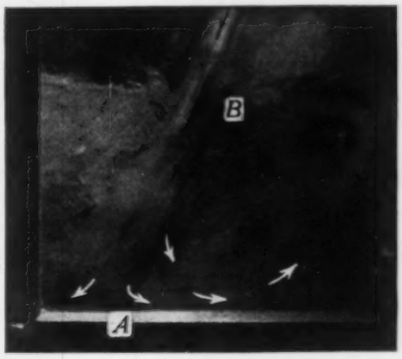


FIG. 1. INCREASE IN WEIR DISCHARGE COEFFICIENT PRODUCED BY REDUCING THE PRESSURE UNDER THE NAPPE

A reduction in the pressure under the nappe of a weir depresses the nappe inward and reduces the weir head a certain amount. Within the limits of the experiments, any given differential pressure head beneath the nappe produced an equal lowering in weir head regardless of the total head on the weir. On each weir-head curve there is a point at which the reduction in weir head produces a 1 per cent increase in the discharge coefficient. A curve connecting these points is the locus of the differential pressure head that cannot be exceeded if the indicated discharge over the weir is not to be affected by more than 1 per cent. Curves of 1, 2, 3, and 4 per cent increase in the discharge coefficient are plotted in Fig. 1.

Air is withdrawn from the under side of the nappe by the falling sheet, which acts as a friction pump. The withdrawn air is replaced either through special inlets provided for the purpose or by circulation of the air withdrawn by the falling sheet, which in striking the channel bottom moves back and upward to the under side of the nappe. The accompanying photograph indicates the manner in which air may return to the under side of the falling sheet by circulation. A measure of the maximum ability of the falling sheet to withdraw air was obtained by the insertion of a deflector, marked *AB* in the photograph, to prevent the effect of back circulation.



HOW AIR CIRCULATES AND RETURNS TO SPACE UNDER A WEIR NAPPE

If an air inlet is assumed to act as an orifice, the calculation of its proper size requires that two factors be either known or assumed: the quantity of air to be delivered to the under side of the nappe, and the required differential pressure head on the inlet. This head, however, must not cause the nappe to be depressed enough to influence the discharge by an appreciable amount.

APPLICATION TO A LARGE WEIR

A concrete example will best illustrate the actual procedure of computing the size of the air inlet. For this purpose, data from a large weir on the main canal of an irrigation system in California will be used. This weir, 60 ft in length, is provided with two inlets, 11 in. in diameter, leading to the space beneath the nappe and is subject to incomplete ventilation. When discharging about 600 cu ft per sec it apparently gave results which were materially in error when compared with current meter measurements.

What size of inlet should be provided if it is desired that discharge measurements be correct within two per cent?

$$\text{Head} = \left(\frac{600}{60 \times 3.33}\right)^{2/3} = 2.07 \text{ ft}$$

The quantity of air required, Q_a, in cu ft per sec per foot of crest length, was found from the laboratory experiments to be, for weir heads between zero and 0.4 ft

$$Q_a = 0.0019\ Q^{2.1} \quad [1]$$

For weir heads greater than 0.4 ft

$$Q_a = 0.0096\ Q^{2.1} \quad [1a]$$

when Q = discharge over weir, in cu ft per sec.
Therefore

$$Q_a = 0.0095 \left(\frac{600}{60}\right)^{2.1} = 1.18 \text{ cu ft per sec per foot of length}$$

The total amount of air carried away by the nappe is then $60 \times 1.18 = 70.80$ cu ft per sec, or $70.80 \times 60 \times 0.0763 = 324.0$ lb per min, when 0.0763 expresses the weight of air under standard conditions, in pounds per cu ft.

From Fig. 1, the differential pressure required to deliver this quantity of air can be obtained. Following

along the curve for H equals 2.07 ft, to its intersection with the 2 per cent curve, it is found that a differential pressure head of 0.135 ft of water on the air orifice cannot be exceeded if measurements over the weir are to be accurate within 2 per cent.

According to Bulletin 240 of the University of Illinois Experiment Station, for a circular orifice the discharge of air, in pounds per minute, is

$$W = 0.8193\ CD^2 \left(\frac{iP}{T}\right)^{1/2} \quad \ldots\ldots [2]$$

in which C = coefficient of discharge = 0.6
W = discharge, in pounds per minute
D = diameter of orifice, in inches
i = differential pressure head, in inches of water
T = absolute temperature of air, in degrees Fahrenheit plus 460
P = average absolute pressure of the air, in pounds per square foot; that is, gage pressure plus atmospheric pressure

Equation 2 gives

$$W = 324.0 = 0.6 \times 0.8193 D^2 \left(\frac{0.135 \times 12 \times 2{,}116.3}{520}\right)^{1/2}$$

Hence D = 16.0 in., the required size of a circular orifice for the entrance of air to the space beneath the weir nappe.

These calculations indicate, as evidenced by actual observation, that the air inlets as installed are of insufficient area for rates of flow greater than 600 cu ft per sec.

It may be well to call attention to the fact that the quantity of air given by Equations 1 or 1a is the total supply necessary. If back circulation adds more air, this is a factor of safety against incomplete aeration. Since the cost of the orifice pipe is not an important consideration, the use of Equations 1 or 1a is advised as preferable to any attempt to make allowance for back circulation.

General Formula for Eccentric Riveted Connections

By FANG-YIN TSAI, ASSOC. M. AM. SOC. C.E.

PROFESSOR OF STRUCTURAL ENGINEERING, NATIONAL TSING HUA UNIVERSITY, PEIPING, CHINA

THERE is widespread need for a general formula that will apply to the design of an eccentric riveted joint consisting of any number of rows of rivets. In the following effort to this end, the only limitations are that all rows contain the same number of rivets and the same uniform pitch, and that the line of action of the eccentric load is parallel to the rows of rivets.

Two common cases will be considered, one in which all the rows of rivets are equally spaced horizontally, and the other in which the rows are not equally spaced, but are symmetrical with respect to the center line of the rivet group.

CASE 1—VERTICAL LINES OF RIVETS EQUALLY SPACED

The following notation has been adopted:

e = eccentricity of load with respect to the center of gravity of the group
h = number of rows of rivets
p = pitch
r = distance from center of gravity of rivet group
v = number of rivets in a row
P = load, with line of action parallel to rivet rows
S = section modulus of a group of rivets
T = total torsional stress in the extreme rivet
V = total vertical shearing stress in the extreme rivet
W = width of strip, or distance between rows of rivets parallel to the axis of the member
ϕ = an angle measured at the center of gravity of a rivet group

Referring to Fig. 1(a) for v and h equal to any integral number, the following values for the polar moment of inertia, Σr^2, of the rivet group and the distance, r_0, of the extreme rivet from the center of gravity of the rivet group may be easily derived, as follows:

$$\Sigma r^2 = \frac{vh}{12}\,[p^2(v^2-1) + w^2(h^2-1)] \ldots\ldots [1]$$

(Equation 1 may be found also in *Bridge Engineering*, by J. A. L. Waddell, M. Am. Soc. C.E., Vol. I, page 299.)

$$\text{and } r_0 = \frac{1}{2}\sqrt{p^2(v-1)^2 + w^2(h-1)^2} \ldots\ldots [2]$$

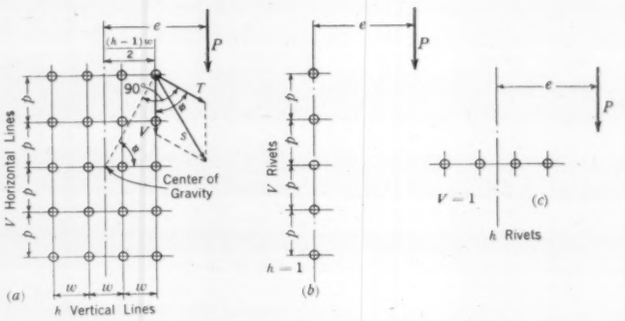


FIG. 1. ECCENTRIC RIVETED CONNECTIONS WITH ROWS EQUALLY SPACED

Therefore the section modulus, S, of the rivet group will be,

$$S = \frac{\Sigma r^2}{r_0} = \frac{vhK}{6\sqrt{p^2(v-1)^2 + w^2(h-1)^2}} \ldots\ldots [3]$$

$$\text{in which } K = p^2(v^2-1) + w^2(h^2-1) \ldots\ldots [4]$$

Referring to Fig. 1(a),

$$s^2 = V^2 + T^2 + 2VT\cos\phi \ldots\ldots [5]$$

$$\text{in which } V = \frac{P}{vh} \ldots\ldots [6]$$

$$T = \frac{Pe}{S} \ldots\ldots [7]$$

$$\text{and } \cos\phi = \frac{W(h-1)}{2r_0} \ldots\ldots [8]$$

Substituting the values of Equations 6, 7, and 8 in Equation 5, we have

$$s^2 = \frac{P^2}{v^2h^2} + \frac{P^2e^2}{S^2} + \frac{P^2eW(h-1)}{r_0vhS} \quad \ldots\ldots [9]$$

Substituting the value of S from Equation 3 in Equation 9 and letting A equal $\frac{P}{s}$, the ratio of the eccentric load to the total stress in the extreme rivet, and simplifying,

$$A = \frac{vhK}{\sqrt{[K + 6eW(h-1)^2] + [6ep(v-1)]^2}} \quad \ldots\ldots [10]$$

This equation is generally applicable to a rivet group consisting of any number of vertical lines of rivets.

When there is only one vertical line of rivets, as shown in Fig. 1(*b*), h equals 1, W equals zero, and K equals $p^2(v^2 - 1)$. Equation 10 is then reduced to the following:

$$A = \frac{pv(v+1)}{\sqrt{p^2(v+1)^2 + 36e^2}} \quad \ldots\ldots [11]$$

When there is only one horizontal line of rivets, as shown in Fig. 1(*c*), v equals 1, p equals zero, and K equals $W^2(h^2 - 1)$. Then Equation 10 is reduced to the following:

$$A = \frac{Wh(h+1)}{W(h+1) + 6e} \quad \ldots\ldots [12]$$

CASE 2—RIVETS SYMMETRICALLY SPACED WITH RESPECT TO CENTER LINE

Next consider the case in which all vertical lines of rivets are not equally spaced but are symmetrically spaced with respect to the center line of the rivet group. Let W_1, W_2, W_3, ... W_n be the distances of the vertical rivet lines from the center line of the rivet group (Fig. 2); let W_n be the distance of the outermost lines from the center line; and let ΣW^2 equal $W_1^2 + W_2^2 + W_3^2 + \ldots + W_n^2$. Then the following relations may be readily deduced:

$$\Sigma r^2 = \frac{vK'}{12} \quad \ldots\ldots [13]$$

$$r_0 = \frac{1}{2}\sqrt{p^2(v-1)^2 + 4W_n^2} \quad \ldots\ldots [14]$$

$$S = \frac{\Sigma r^2}{r_0} = \frac{vK'}{6\sqrt{p^2(v-1)^2 + 4W_n^2}} \quad \ldots\ldots [15]$$

$$A = \frac{vhK'}{\sqrt{[K' + 12ehW_n]^2 + [6ehp(v-1)]^2}} \quad \ldots [16]$$

in which

$$K' = hp^2(v^2 - 1) + 24\Sigma W^2 \quad \ldots\ldots [17]$$

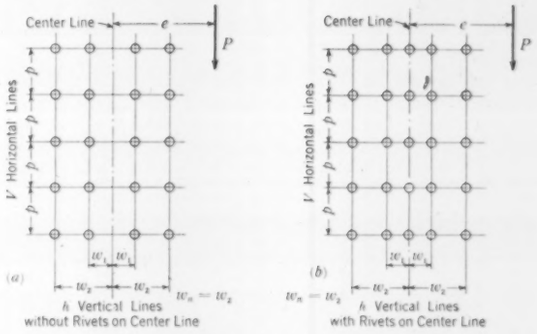


FIG. 2. ROWS OF RIVETS SYMMETRICAL ABOUT CENTER LINE BUT UNEQUALLY SPACED

Equations 13 to 17 are applicable to both the cases shown in Fig. 2, that in which there is no rivet on the center line, and that in which there are rivets on the center line.

When there is only one horizontal line of rivets, v equals 1; p equals zero; K' equals $24\Sigma W^2$; and Equation 16 is reduced to the following:

$$A = \frac{1}{\frac{1}{h} + \frac{eW_n}{2\Sigma W^2}} \quad \ldots\ldots [18]$$

When there is only one vertical line of rivets, the problem becomes that of Case 1. Hence Equation 11 is applicable.

Welded Steel Pier Recently Completed

DURING the past year a steel pier a half mile long has been constructed through the surf on an open beach at Davenport, Calif. The pier was built for the Santa Cruz Portland Cement Company for loading bulk cement on steamships for distribution to various points on the West Coast. It carries a standard-gage railroad track, a walkway, two 12-in. pipe lines through which dry cement is pumped to the ships, a 6-in. line for fuel oil, and a 3-in. water line. Each 12-in. pipe line has a capacity of 1,000 bbl of cement per hour.

For supporting the pier, structural steel H-beams driven to refusal were used as piles, three to a bent, the two outside ones being driven with a batter of 12 on 1. For the first 840 ft of the pier, extending to the breaker line, the piles are 33-lb sections, braced with angles, attached by welding and capped by 12 by 12-in. timbers. Through and beyond the breaker line to the end of the pier heavier construction was used, employing 10-in., 49-lb H-beams, each driven to refusal inside of a steel cylinder. The cylinders were driven through the sand to a seat on the underlying shale, which extends the length of the pier. After an H-beam pile had been driven inside of each cylinder, the sand and water was removed and the interior of the cylinder filled with concrete. All sash braces, longitudinal struts, cross bracing, and steel channel caps were attached by welding without the use of a single bolt or rivet. In all, more than 26,000 lin ft of welds were required.

The pier head, 36-ft square, is supported on four 7-ft cylinders each anchored in the shale by six H-beam piles driven to refusal and filled with concrete. When taking a cargo, a ship is held off the pier by eight 16,000-lb anchors, and its bow is kept pointed seaward.

The cylinders are tied together with structural steel welded in position. To place the cylinders, falsework piles and 34 steel H-beams were driven. The latter were cut off at the ground line by a diver using an oxy-electric under-water cutting torch.

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LOADING BULK CEMENT AT DAVENPORT, CALIF., PIER

Cement Pumped Through 12-In. Pipe Lines

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Data on the Design of Concrete

To the Editor: The method of designing concrete for bending, and direct stress, presented by Mr. Mitchell in the October issue, gives correct results. However, since the solution of examples requires the use of his Table I, and since generally values must be interpolated, it seems that a more direct method can be used for such examples as are given in the article.

The notation will be that employed in the article with the addition of the following: R = coefficient of strength or resistance of the concrete = 107.5 for values of f_s = 16,000 lb per sq in. and f_c = 650 lb per sq in., f'_s = compressive stress in steel, k = 0.378 for values of f_s = 16,000 lb per sq in., and f_c = 650 lb per sq in. These values are based on n = 15, as used by Mr. Mitchell.

Using the values given in Mr. Mitchell's Fig. 1,

$$\frac{R\,b\,(d)^2}{e_1} = N = 30{,}000 = \frac{R\,(14)\,(27)^2}{33}.$$

The value of R is then found to be 97.1. Referring to diagrams as given in most textbooks on reinforced concrete, it will be found that f_c is less than 650 lb per sq in. and the value of k is 0.364 when f_s = 16,000 lb per sq in., which makes kd equal to 9.83 in.

The amount of tension steel required will be

$$\frac{30{,}000\left(6 + \frac{kd}{3}\right)}{16{,}000\left(27 - \frac{kd}{3}\right)} = \frac{30{,}000\ (\ 9.277)}{16{,}000\ (23.723)} = 0.73 \text{ sq in.}$$

Mr. Mitchell gives 0.73 sq in. Using the values as given for his Fig. 2, the thrust that the concrete will resist will be

$$\frac{107.5\ (14)\ (27)^2}{33} = 33{,}250 \text{ lb.}$$

As the total thrust is 36,000 lb, this means that steel must be provided to resist 2,750 lb in compression. The compressive stress in the steel will be:

$$f'_s = (15 - 1) f_c \left[\frac{(0.378)\ (27) - 3}{(0.378)\ (27)}\right] = 6{,}425 \text{ lb per sq in.}$$

The area of the compression steel then is

$$\frac{(2{,}750)\ (33)}{(6{,}425)\ (24)} = 0.59 \text{ sq in.}$$

Mr. Mitchell gives 0.60 sq in.

The amount of tension steel required to resist the compressive stress in the concrete is

$$\frac{(33{,}250)\left(6 + \frac{kd}{3}\right)}{(16{,}000)\left(27 - \frac{kd}{3}\right)} = \frac{(33{,}250)\left(6 + \frac{10.21}{3}\right)}{(16{,}000)\left(27 - \frac{10.21}{3}\right)} = 0.83 \text{ sq in.}$$

The amount of tension steel required to resist the 2,750 lb remaining above what the concrete will resist is

$\frac{(2{,}750)\ (6 + 3)}{(16{,}000)\ (27 - 3)} = 0.06$ sq in., making a total of 0.89 sq in. of tension steel required, given by Mr. Mitchell as 0.90 sq in.

It seems to me that this method is more in line with that ordinarily used in beam design, and the results can be derived very readily. All calculations have been made with a 20-in. slide rule.

A. W. Fischer
Pennsylvania Sugar Company
Philadelphia, Pa.
January 27, 1935

Importance of Central Valley Project

To the Editor: The article by Mr. Hyatt on the Central Valley Project of California, in the September issue, is very interesting. It is difficult to express proper appreciation for the broad and comprehensive planning that has resulted in the project and for the care and detail with which the plans have been prepared. The Central Valley comprises the greater part of the arable lands of California, and it must be maintained in a high state of fertility if the population of the state is to continue to grow. The present dry cycle and the intrusion of salt water have tended to reduce both the area and fertility of the valley.

The project contains practically all the elements of conservation, in that it provides for additional water supply for lands already under cultivation; for stream control both for the regulation of low flow and for flood prevention; for the improvement of navigation; and for power development. It will also prevent the disastrous intrusion of salt water into the Sacramento estuary, with consequent benefits to agriculture, manufacturing, and public water supplies. The project does not involve the development of new territory, but the conservation and improvement of territory already developed and quickly populated. Although the total amount of money involved in the project is apparently large, the State of California is willing to bear the greater share of the burden, and the immediate benefits that should result will be sufficient to ensure liquidation of these burdens through the payment of charges and of the principal.

For many years the problems involved have been made the subject of intelligent study by the Federal Government, represented by the Corps of Engineers, and by the state, represented by its Engineering Department. The results have been the preparation of a carefully coordinated plan which evaluates the interests of each. Seldom has a project of this magnitude evoked so little technical or economic criticism.

It is expected that a considerable part of the revenue for liquidation will derive from the sale of hydro-electric power. The price at which this power can be developed is reasonable, and its absorption has been computed on a conservative basis. The available market has a present annual consumption of over 10 billion kilowatt hours, and even with the additional supplies of power which should soon be available from Boulder Dam, it should be possible to market the additional power within a reasonable space of time. Because of the large amount of storage available in both the Central Valley and the Boulder Dam projects, the addition of these large quantities of hydro-electric power should not be sufficient to disturb unduly the balance between steam and water power that has been found so necessary, particularly in California.

It is greatly to be regretted that the Central Valley Project was not available for consideration when the original appropriation of $3,300,000,000 was made available for public works. The great care taken in preparing and assembling the data on the project and the necessity for obtaining enabling legislation made it impossible to present the project until after the allotments were made. However, the completeness of the present plans will make it possible to get the work under way as soon as additional funds are available.

There is a tendency on the part of certain Eastern engineers to lump all Western projects together and to criticize them on the basis of preconceived notions or formulas. It would be much better if each project could be submitted to a critical analysis based upon its real merits. Furthermore, it must be remembered that the West is in a much less advanced stage of engineering development than the East and that much more real building is necessary for its immediate development. In my opinion the Central Valley Project will stand the most critical and searching engineering and economic analysis.

John P. Hogan, M. Am. Soc. C.E.
Parsons, Klapp, Brinckerhoff and Douglas
New York, N.Y.
February 1, 1935

Neutral Axis Analytically Located

TO THE EDITOR: I wish to comment on the graphical method described in Mr. Osgood's article, entitled "Neutral Axis in a Reinforced Concrete Member Subjected to Combined Stress," in the October issue. This method is similar to that described on page 40 of the ninth edition of *The Theory and Practice of Modern Framed Structures* by J. B. Johnson, C. W. Bryan, and F. E. Turneaure, which is given in reference to plain concrete section only. On the other hand, the limit of the application of these graphical methods is set by the percentage of steel. When this percentage is low then the position of the point n cannot be accurately determined, and consequently the intercept z becomes erratic. It appears that the limit of application of this method is at about 2 per cent steel. When a smaller percentage of steel is employed in an irregular section, then an analytical cut-and-try method seems to be the most advantageous for locating the neutral axis. Since P is a compressive force and M a positive clockwise moment, the formulas for these methods are as follows:

For sum of stresses:

$$\Sigma Af = \frac{f_c}{kt}\left\{\sum_{0}^{kt} A_c x_c + (n-1)(\Sigma A_s' x_s' + \Sigma A_s x_s)\right\} = C_P f_c$$

and for moment of stresses about the center of gravity of the section:

$$\Sigma Afe = \frac{f_c}{kt}\left\{\sum_{0}^{kt} A_c x_c e_c + (n-1)(\Sigma A_s' x_s' e_s' + \Sigma A_s x_s e_s)\right\} = C_M f_c,$$

in which k = length of compressed part of the section
t = length of the section
x = distance from the neutral axis to any elementary area of concrete or to the steel bar
e = length of lever arm from the center of gravity of the section to any elementary area of concrete, or to the steel bar
A_c = elementary area of concrete
A'_s = area of a steel bar in compression
A_s = area of a steel bar in tension
f_c = maximum stress in the concrete in compression

Subscripts c and s refer respectively to concrete and steel.

The ratio $\frac{C_M}{C_P} = e_f$ and its divergence from $e = \frac{M_g}{P}$, found by using the actual moment, M_g, and the normal force P, will indicate the correctness of the assumed value of k.

For P, when a tensile force, the value ΣAf is negative, so that $e_f' < 0$, which corresponds to $e < 0$. The distance of the center of gravity of the transformed section from the edge of the section is found from the expression:

$$C_g = \frac{\sum_{0}^{t} A_c C}{\sum_{0}^{t} A_c} = \frac{\sum_{0}^{t} A_c C + (n-1)(\Sigma A_s C_s + \Sigma A'_s C'_s)}{\sum_{0}^{t} A_c + (n-1)(\Sigma A_s + \Sigma A'_s)},$$

in which C is the length of the lever arm from the edge of the section to an elementary area of concrete, or to a steel bar.

I. M. NELIDOV, Assoc. M. Am. Soc. C.E.
Senior Engineer of Hydraulic Structure Design, State Department of Public Works
Sacramento, Calif.
January 24, 1935

Determining Concrete Quantities

TO THE EDITOR: In the August issue, W. J. Harris, Assoc. M. Am. Soc. C.E., presented a very interesting subject in his article on "Concrete Quantities by Absolute Volume Method." A few comments on this subject may prove of further interest.

In the early nineties, René Feret, an eminent French engineer, first employed absolute volume as the basic measure of ingredients, including mixing water, and developed the fundamental law of concrete mixtures. According to this law, the volume of concrete produced by a mixture of aggregates, cement, and water is equal to the sum of the absolute volumes of the aggregates, cement, water, and entrapped air. Until a comparatively recent date, very little advantage has been taken of the knowledge of this method for computing concrete quantities, and even now it is brought into use infrequently except in laboratories where tests on concrete and concreting materials are carried out on a comparatively large scale. If the method were used in the field more often, many of the concrete problems met on construction work—such as yield, cement factor, and uniformity of quality—would become simpler and easier to handle. The method may seem a trifle complicated at first glance, but once it is understood, it becomes very useful, and every engineer who deals with concrete should utilize it.

In designing mixtures on the basis of absolute volume, it is essential only to determine the specific gravities of the constituent materials. On the other hand, if the unit weight and voids are also determined, as is often the case, the resulting interrelationship serves as a check on the specific gravity value determined by test. The interrelationship of these three characteristics of granular materials is shown in the following equation:

$$V \times 62.4 \times S = (62.4 \times S) - W$$

In which V = percentage of voids in the material
S = specific gravity of the material
W = unit weight of the material

Therefore, $S = \frac{-W}{(V \times 62.4) - 62.4}$

If this computation of the specific gravity of the material from the known values for unit weight and percentage of voids checks the determination by actual test, then it is almost a certainty that the value obtained is the correct one. If it differs, however, a check test is indicated. The foregoing equation will be convenient in cases where field weights are determined from unit weights.

Equation 2 of Mr. Harris' article, which is evolved from his Equation 1, offers an excellent means of checking the total weight of the aggregate after the individual weights of the various sizes of aggregates to be used have been computed. Since Equation 2 is based on certain assumptions, it would be necessary to revert to Equation 1 if the assumed values should change, in order to determine new constants for the second equation. This procedure is a trifle involved, and some of the assumptions in Equation 1 may be subject to change. For instance, the specific gravity of cement may be 3.25 instead of 3.1. The following equation, which I have found useful in helping to compute concrete quantities, is similar to Equation 2, but I consider it somewhat more flexible:

$$A = 62.4 \frac{S_L S_f}{R S_L + R_l S_f}\left[27 - F\left(\frac{94}{62.4 S_c} + \frac{W}{C}\right)\right]$$

In which A = total weight of fine and coarse aggregate
S_L = apparent specific gravity of coarse aggregate
S_f = apparent specific gravity of fine aggregate
S_c = apparent specific gravity of cement
R = ratio of fine to total aggregate
R_l = ratio of coarse to total aggregate
F = cement factor (sacks of cement per cu yd of concrete)
W/C = water-cement ratio by volume

It is always gratifying to those who are interested in concrete to read articles on the subject. Such material is appearing more and more frequently in engineering literature, and it reflects the growing interest of the profession in concrete.

JOHN C. SPRAGUE, Assoc. M. Am. Soc. C.E.
Huntington, West Va. *Inspector, Corps of Engineers*
February 4, 1935

Time for Locomotive Acceleration

TO THE EDITOR: In the July issue there was a letter by Brent C. Jacob, discussing my article on "Problems in Locomotive Acceleration," in the April number. In this discussion Mr. Jacob presented a graphical method utilizing time-velocity and time-distance curves to greatly shorten the labor of solving some of these problems. Since the publication of my original article, I have developed a much shorter analytical method of solving some of these problems. This method involves finding the mean value of the tractive power (T) of the locomotive by the application of

calculus to the equations expressing the relation between tractive power and speed. This value is then used in the well-known formula

$$L = 70\,\frac{W}{T}(S_2^2 - S_1^2) \quad \ldots\ldots\ldots\ldots [1]$$

the notation being the same as in my article. This is done by finding the area under the curve of tractive power and the x-axis and between the ordinates erected at the limits of speed and by dividing by range of speed.

From calculus we get

$$dA = y\,dx, \text{ or } A = \int y\,dx$$

For an illustrative problem, using Equation 2 of my article and assuming a level track:

$$T = \int\left(\frac{205.3}{S} + 3.47\right) dS = \left[205.3 \log_e S + 3.47\,S\right]_{S_1}^{S_2}$$

To find the time to accelerate on a 0.5 per cent grade from 12 to 18 miles per hr, k will be $3.47 - 10 = -6.53$.

Then $T =$

$$\frac{[205.3 \times 2.8904 + (18 \times -6.53)] - [205.3 \times 2.4849 + (12 \times -6.53)]}{18 - 12 \text{ (range of speed)}}$$

$$= 7.36 \text{ lb per ton}$$

Substituting in Equation 1 and making W equal to 1 ton,

$$L = \frac{70}{7.34}(18^2 - 12^2) = 1{,}710 \text{ ft}$$

Substituting in the equation,

$$t \text{ (in seconds)} = \frac{15}{11}\left(\frac{L}{S_2 + S_1}\right);\ t = 77.7 \text{ sec}$$

When a train is accelerating its speed, the wheels are given not only an acceleration of translation, but also an acceleration of rotation, which requires additional power. Nearly all textbooks on applied mechanics give formulas for such acceleration. The formulas in my original article do not include that factor. However, the problem may be solved by the use of the formulas there shown as readily as with others. When solving for the time to accelerate from a speed less than that for which the locomotive is loaded to the maximum speed attainable for that loading, the use of my Equation 10 will simplify the calculation. Attention is called to the fact that when in this case the limiting speed is substituted in the equation it equals zero. The time then is obtained by substituting the initial speed alone.

In solving problems involving the maximum grade, or grades approaching that value, great care should be taken to determine the value of the constants in the equations, or the results obtained will not be reliable. This is not peculiar to this particular method but applies to all methods in common use. A widely used textbook, *Railroad Engineering*, by W. R. Raymond, gives 4,677, 3,380, and 3,867 ft, respectively, as the distances required to accelerate a locomotive from 12 to 18 mph, by using the higher, the lower, and the average value of t for speeds varying by only one mile per hour.

The time required to solve problems by these equations may be greatly shortened by using a planimeter to secure the area under the curve of tractive power and a nomographic chart to solve the equation for L. Such a chart, shown in Fig. 1, is made for the equation $L = \frac{70}{T}S^2$ in which L is the distance in feet, and T the tractive power per ton of train. To find, from this chart, the distance to accelerate from a speed higher than zero to a still higher speed, find the distance to accelerate from zero to the higher speed, then from zero to the lower speed, and take the difference. The lines on the chart are drawn to find the distance to accelerate from 12 to 18 miles per hr the problem already solved. It is possible to design a chart with four parallel scales and an ungraduated scale, known as pivot or turning scale, that will solve this equation for one unknown. Also a Z-chart may be designed for the same purpose, but two readings will be required in each case. The chart shown in Fig. 1 is as simple as any that may be designed for the solution of this equation.

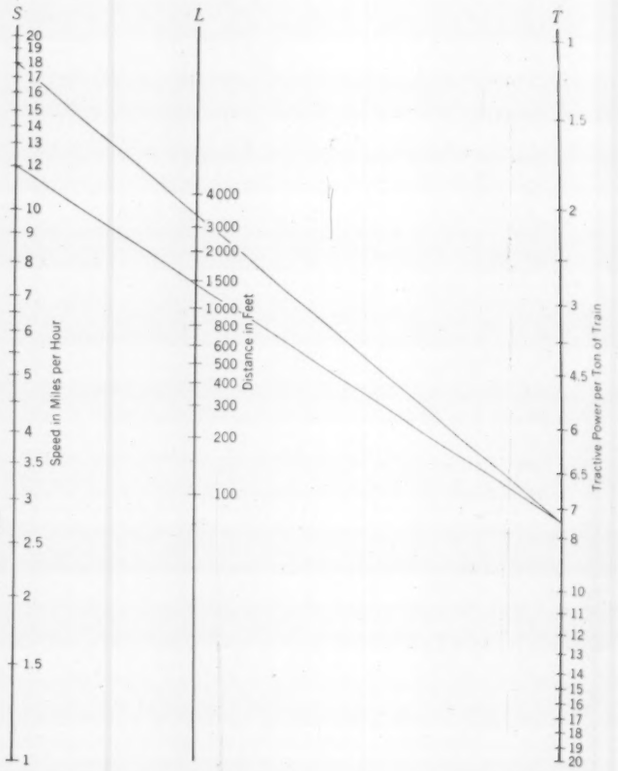


FIG. 1. MONOGRAPHIC CHART FOR SOLUTION OF $L = \frac{70}{T}S^2$

A. C. BARROW, Assoc. M. Am. Soc. C.E.
Assistant Professor of Civil Engineering
Alabama Polytechnic Institute
Auburn, Ala.
February 8, 1935

Data on Position of Cutting Edge

TO THE EDITOR: As assistant resident engineer on the Berwick Bay Highway Bridge, Morgan City, La., which was completed in 1933, it was my duty to follow the position of cutting edge and the behavior of the four river piers. These piers were built up in 8-ft lifts, and a freeboard of from 1 to 12 ft was maintained. They were sunk by pneumatic and open excavation. After each pier was sealed, the hole was pumped out. Then a plumb line was dropped to the top of the seal, and the true position of the cutting edge was located. The results are shown in Table I.

A true location of the cutting edge was made with a plumb bob just before the air was removed from Caissons Nos. 2, 5, and 3, and corrections were made on them but not on Caisson No. 4.

To satisfy a natural curiosity it would be interesting to compare these results with those obtained on similar jobs. Work on the Berwick Bay Bridge was carried out under the direction of P. V. Pennybacker, Assoc. M. Am. Soc. C.E., resident engineer.

R. L. BARNES, M. Am. Soc. C.E.
Resident Engineer, State Highway Commission
Lottie, La.
January 16, 1935

TABLE I. POSITION OF CUTTING EDGE OF CAISSONS FOR BERWICK BAY HIGHWAY BRIDGE

Item	Pier No. 2	Pier No. 5	Pier No. 3	Pier No. 4
Elevation of cutting edge when air was removed	−86.8	−79.1	−109.0	−128.9
Actual position of cutting edge, when sealed, in inches from true position	1½S–3E	½S–½E	1S–3W	6½N–2½E
Computed position of cutting edge, when sealed, in inches from true position	1¼S–2¾E	2S–½E	2½S–5½W	7N–3¾E
Elevation of cutting edge when sealed	−112.9	−135.8	−176.5	−144.0
Diagonal list of caisson in inches for given height in feet	8¼–118.7	3–141.6	5½–182.3	2½–149.8

SOCIETY AFFAIRS

Official and Semi-Official

Walter E. Jessup Appointed Field Secretary

A NEW and important post in the Society organization, that of Field Secretary, is being assumed as of March 1, 1935, by Walter E. Jessup, M. Am. Soc. C.E. This development, an outgrowth of the study and recommendations of the Committee on Aims and Activities, was authorized by the Board of Direction at its January meeting. Mr. Jessup is no stranger to Society affairs as he has held the responsible position of editor of CIVIL ENGINEERING since its inception in 1930, and therefore is well acquainted with Society traditions, activities, and personnel.

WALTER E. JESSUP

When CIVIL ENGINEERING was initiated Mr. Jessup came to New York from his home in Los Angeles, the intent at that time being that as soon as the character of CIVIL ENGINEERING should be established, and he might turn that work over to someone else, he would take on just such duties as have now been defined as for a Field Secretary. Society finances heretofore have not permitted the expansion then in mind. Two younger men will be selected to assist in the editorial department, and CIVIL ENGINEERING will devote more space to information about Society affairs.

Mr. Jessup was born in Pasadena, Calif., May 25, 1888. His father was a civil engineer and Mr. Jessup, as a small boy, assisted his father at the end of an old-fashioned link chain. His summer vacations were spent on railway and municipal survey work.

He received the degree of bachelor of arts from the University of Southern California in 1910, and that of civil engineer from the University of Wisconsin in 1912. He was appointed student assistant in railway engineering while at Wisconsin. He was elected to Tau Beta Pi and was president of the chapter in 1912.

Following graduation, he was successively engaged in field engineering in connection with the construction of the Los Angeles Aqueduct; on the hydro-electric development at Big Creek, Calif.; on the location and construction of highways for the California State Highway Commission; and on the final construction by the U. S. Reclamation Service on the Salt River Project, Arizona. In 1917 he was resident engineer on the ballasting and bridge replacement program of the San Pedro, Los Angeles and Salt Lake Railroad in California and Nevada.

Two years in the Army followed, during which he saw 16 months' service in France as First Lieutenant with the 39th Engineers. He now holds a reserve commission as Major of Engineers.

On his return from the War, Mr. Jessup entered the employ of Quinton, Code and Hill, of Los Angeles, as assistant engineer on the investigations, valuation, design, and construction of irrigation, water supply, and power projects in Arizona, California, and Mexico. In 1924 he opened a consulting office in Los Angeles in partnership with Henry Z. Osborne, M. Am. Soc. C.E., and for six years maintained a practice devoted to valuation and rate cases and to municipal, hydraulic, and sanitary developments. The partnership was dissolved in 1930 to permit him to take up duties as editor of CIVIL ENGINEERING.

During all his connection with the Society, since 1914, he has been a member of the Los Angeles Section, editing its publication, the *ASCE*, and serving as its president in 1929. He was also a member of the Pasadena Engineers Club and the Joint Technical Society of Los Angeles, being secretary of the latter organization in 1930. He was one of the founders of the Los Angeles Alumni Club, Tau Beta Pi, serving as its secretary-treasurer for 14 years. He joined the Society as a Junior in 1914, was advanced to the Associate Member grade in 1919, and became a Member in 1926.

Engineers' National Relief Fund

CERTAIN gifts of money were donated in 1931 as a national fund for the purpose of relieving distress by loans to members of the four Founder Societies, especially to those members located in isolated communities where Local Sections did not exist or could not render assistance. Because the loan fund was not large enough to divide among the societies, a board was organized on January 14, 1932, on which each of the four national societies was represented, to direct the disbursement of the fund. Since its organization the board has held 20 meetings to formulate policies and act on relief cases.

The fund at the disposal of this board totaled $6,845.57. All loans have been made without interest and for as short a period as consistent with providing the emergency service required, thus creating a revolving fund. Transactions made to January 14, 1935, include 90 loans, to 74 engineers located in 18 states and Canada, totaling $7,156.00. Of this amount, $1,345.00 has been returned and is again available for the relief of the emergencies of other hard-pressed members of the profession. The need for assistance has been investigated in each case by the nearest local organization or society member to determine the living conditions of the engineer in distress, his resources, and the proposed use of the money. The loans made from the fund not only have provided for food, rent, and clothing, but have been used several times to provide transportation to definite jobs. In two cases the home of the engineer was saved by the loan from loss by foreclosure.

The Board of Direction of the Engineers', National Relief Fund consists of William G. Atwood, M. Am Soc. C.E., chairman; Landon F. Strobel, A.I.M.E., vice-chairman; Edward B. Meyer, A.I.E.E., treasurer; William A. Shoudy, A.S.M.E.; and Ernest Hartford, A.S.M.E., secretary.

Arizona Section Aids Planning Board

AS AN AID to the Arizona State Planning Board, the Arizona Section of the Society undertook in 1934 a comprehensive survey of the power facilities in the state. The report rendered by the Section was of such value that a copy of it was sent to the National Resources Board. A resolution of the Arizona State Planning Board was passed unanimously at its meeting on January 11, 1935. The copy of it, which follows, speaks for itself.

WHEREAS, the Arizona Section of the American Society of Civil Engineers did under date of May 7, 1934, so kindly offer the services of the Arizona Section in furthering the program of the Arizona State Planning Board; and

WHEREAS, the Arizona State Planning Board, after due consideration, determined that the most valuable service which could be rendered would be the preparation of a comprehensive report on the power possibilities of the State of Arizona; and

WHEREAS, this report has been prepared and was presented by the Arizona Section of the American Society of Civil Engineers to the Arizona State Planning Board at its meeting on January 11, 1935; now therefore be it

Resolved, that the Arizona State Planning Board express its deep appreciation of the exceedingly valuable services rendered, and thank the Arizona Section of the American Society of Civil Engineers for this very splendid report. Be it further

Resolved, that this resolution be spread on the minutes of the meeting of the Arizona State Planning Board and that a copy of the same be forwarded to the National Resources Board, Washington, D.C., to the American Society of Civil Engineers, and to the Arizona Section of the American Society of Civil Engineers.

Survey of the Engineering Profession

Civil Engineers Cooperate Through Comprehensive Questionnaire

IT IS generally admitted that the professional engineer has suffered acutely since 1930. Besides bearing a full share of the burdens imposed on everyone by a depression, he has suffered an almost complete cessation of practice in the field financed from private and industrial sources because of the stoppage of private construction. If in municipal, county, or state employ, he has been hard hit by the early collapse of normal public works con-

SORTING CARDS FOR NATION-WIDE SURVEY OF THE ENGINEERING PROFESSION
Scene at Society Headquarters During February 1935

struction when it became impossible to finance such work by the sale of bonds. Further, cities in many instances have discharged their Civil Service employees, replacing them from relief rolls or other sources. There has been only partial reemployment under such Government agencies as the PWA and CWA. If in the class of consultants, the engineer has had practically no remunerative employment although he has had to bear a staggering burden of normal overhead expenses; he may have gone out of business altogether. If in Federal employ or in the teaching profession, he may have had a measure of security, but has also felt acutely the financial stringency. If on relief work, he has had to accept in many cases enormously lowered standards of living, to adjust himself to perform tasks much below his professional capabilities, and to accept, temporarily at least, many inequitable conditions.

What can be done to help him? Obviously, nothing can be done without facts. These facts are now being sought by the questionnaire method.

Probably early in March, a questionnaire will be forwarded to thousands of men in the United States who think of themselves as engineers, from sub-professional men and recent graduates to chief engineers and consultants. It will be sent to civil, mechanical, electrical, mining, and chemical engineers—to those in all the many branches of engineering. This project is being undertaken by the U. S. Bureau of Labor Statistics at the request, and with the cooperation of the American Engineering Council and the several engineering societies. More than 170,000 questionnaires are to be sent out to engineers in all parts of the country.

The objects of the survey are to determine the factors which contribute to tenure of employment and compensation, degree of unemployment, and sources of reemployment; to throw light on the influence of education or place of employment upon compensation, to investigate the relationship of engineering employment to that in other professions. Education, years of experience, types of work, place of practice, nature of previous employment (whether continuously in one organization or in one type of work or scattered among several), membership in professional or technical societies, registration in states that require it, salaries received in the past, typical duties, and special qualifications—all these elements and many others may have a definite bearing on the present condition of the engineer.

To make the survey as comprehensive and as useful as possible, the form of the questionnaire has been worked out by Dr. Isador Lubin of the Bureau of Labor Statistics with the aid of members of the several engineering societies, selected for their experience in employment studies. The bureau is to print and mail the questionnaires, receive and analyze the returns, and publish the results. The answers will be punched on tabulating cards and fed through sorting machines. Thus the splendid clerical and mechanical facilities of the Bureau of Labor Statistics and the use of its franking privilege will eliminate any large direct expenditure.

One thing the bureau cannot do, however, is to obtain and prepare the mailing list. On behalf of the American Engineering Council, the American Society of Civil Engineers has furnished space, the time of staff assistants, and the incidental expenses for correspondence and postage to obtain and prepare these lists. What is necessary is a file of names and addresses, stenciled or typed on 3 by 5-in. cards, sorted by states, and arranged alphabetically, with obvious duplicates laid aside.

Securing the cards has been no small task. Requests were sent to 233 engineering societies, associations, and clubs; to 32 state registration boards; and to 156 engineering schools, asking that cards be prepared and sent to Society Headquarters. In the case of the engineering schools, data concerning graduates of the last five years only were requested. When it is realized that 203,000 cards have been received, it is obvious why cards were needed instead of lists or year books.

The 1930 Census indicated that 226,136 persons in the United States considered themselves engineers. Elimination of duplicates in the cards received have reduced their net total to 170,000, or about 75 per cent of the census total for 1930, a surprisingly large sampling of the profession. The distribution of the 203,000 cards, among the 226 groups from which they were received, is shown in Table I.

TABLE I. CARD RETURNS AS OF FEBRUARY 15, 1935

SOURCE	NUMBER SOLICITED	NUMBER SUPPLYING CARDS	NUMBER OF CARDS RECEIVED
National societies	73	35	103,700
State societies	39	20	12,100
Local societies	121	43	26,700
State registration boards	32	15	9,200
Engineering colleges	156	113	51,200
Totals	421	226	202,900

This remarkable response is extremely gratifying. It indicates the intense interest of engineers in their own welfare. In the case of many of the collaborating groups, it has been a real task and frequently an irksome one, to put the membership list on cards. The cooperation has been splendid, however, and but few have reported inability to help—and then usually because of financial hindrance or some technical handicap.

To solicit, collect, and acknowledge the cards required the time of two members of the Society's staff for almost six weeks. To sort and arrange the cards at Society Headquarters, 12 specially qualified women chosen from the unemployment relief rolls of New York were assigned. The time of these workers for 1,105 hr and the time of various staff members for 392 hr has been devoted to the task.

There will still remain some engineers who do not belong to any organization. Since it is the hope to send a questionnaire to every engineer in the country, it will help if any person who knows of an unaffiliated engineer will send his name and address on a 3 by 5 in. card direct to Dr. Isador Lubin, Bureau of Labor Statistics, Department of Commerce, Washington, D.C., so that it may be placed in the card file now there.

In addition, names and addresses are greatly desired for those former members of organizations who have had to drop out within the last few years for financial reasons. Such men, having borne the brunt of the economic slump, most certainly should receive questionnaires.

Questionnaires will be kept absolutely confidential, and need not be signed by the individual returning them. No person connected with the work is interested in the individual returns. It is certain, however, that large numbers of engineers will be interested in the published results of the analysis. Each individual engineer will realize that this nation-wide survey will result in a satisfactory analysis only if he fills out his report completely and sends it in promptly.

United Engineering Trustees, Inc., Reports

FOR THE PURPOSE of holding the legal title to certain of the real property of the four Founder Societies, a corporation, now known as the United Engineering Trustees, Inc., was formed in 1904. The principal item of property is the Engineering Societies Building in New York, at 29–33 West 39th Street. This building houses the national headquarters of the Founder Societies, other allied organizations, and the Engineering Societies Library. It adjoins, but is not a part of the Engineers Club of New York. The Engineering Societies Building contains the headquarters of organizations representing a membership of about 80,000 engineers.

The United Engineering Trustees stands under and not over the Founder Societies; it performs certain specific acts which are governed by contract, but there is no merger of the societies. Each retains its individuality. Its business is conducted by a board of 12 trustees, three from each Founder Society. One new trustee is elected each year by the governing body of each society to serve for a three-year term. The trustees representing the American Society of Civil Engineers during 1934 were Arthur S. Tuttle, President Am. Soc. C.E. for 1935, John P. Hogan, Vice-President Am. Soc. C.E., and C. W. Hudson, M. Am. Soc. C. E. In January 1935, when President Tuttle's term expired, Otis E. Hovey, Treasurer Am. Soc. C.E., was appointed to fill the vacancy.

Not only does the United Engineering Trustees, Inc., hold the title to, and manage the real property of the societies but it also acts as trustee for all trust funds given to them jointly. It administers the principal of the funds of the Engineering Foundation, endowed for the purpose of furthering research in science and in engineering, the funds for the maintenance of the societies' free public engineering library, and a depreciation and renewal fund for the building.

Properties for which the corporation is responsible are valued at a total of nearly $4,000,000. Of this, $1,988,000 represents the cost, to date, of the land and building at 29–33 West 39th Street, New York, which is the Engineering Societies Building; $1,390,000, the aggregate book value of funds and investments on December 31, 1934; and $480,000, the value of the library as appraised for fire insurance.

The United Engineering Trustees entered 1934 with its budget stripped of every operating expenditure that could be postponed. Some of the active problems which faced the trustees included meeting occupancy competition with other buildings; the great responsibility of obtaining income from its funds held in trust for active research and at the same time maintaining the security of the principal; aiding the Founder Societies and associates by continuing to make rebates in occupancy assessments; and keeping operating budgets at absolute costs. Fortunately the business cycle seemed to turn upward during the year and income from the use of meeting halls and facilities was somewhat better than anticipated. Some income-producing office space was released, but much of this was filled promptly. Returns from investments were fully up to expectations. The market advanced during 1934 on practically all securities held by the corporation.

Owing to a study made several years ago of ways and means to rebuild, certain improvements to the present building had been deferred. Justifiable criticism demanded that some of these be made. During the year the assembly halls on the fifth floor and the main floor lobby were redecorated; lobby furniture and auditorium seats were re-upholstered, new chairs were provided for the assembly hall; and new and adequate illumination was supplied in office space and assembly halls. All these improvements have been marked by general commendation and appreciation on the part of occupants and users.

During the year, Dr. Alfred D. Flinn, M. Am. Soc. C.E., who for 17 years had rendered invaluable service as secretary of the corporation, asked to be relieved of a part of his duties. On June 25, 1934, John Arms, general manager, was elected to succeed Dr. Flinn as secretary. Dr. Flinn has continued as a director of the corporation and as secretary of the Engineering Foundation, and Mr. Arms has continued as general manager of the United Engineering Trustees, Inc.

At its meeting on January 24, 1935, the United Engineering Trustees adopted a revision of its by-laws providing for an official and fiscal year beginning October 1 of each calendar year, thus affecting the terms of trustees and officers and the period of the budget. The following officers were elected for 1935: president, Harold V. Coes, the American Society of Mechanical Engineers; first vice-president, George L. Knight, the American Institute of Electrical Engineers and the American Society of Mechanical Engineers; second vice-president, H. G. Moulton, the American Institute of Mining and Metallurgical Engineers; secretary, John Arms, the American Society of Mechanical Engineers; treasurer, Clifford P. Hunt, vice-president of the Chemical Bank and Trust Company; assistant treasurer, Otis E. Hovey, the American Society of Civil Engineers.

Paragraph Seven of the Code of Ethics

IN CONNECTION with the recent adoption of an additional paragraph in the Society's Code of Ethics, the committee which had the matter under consideration has received several statements of policy from engineering schools. To the over-all statement in the Code that, "It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member of the American Society of Civil Engineers," the new paragraph which has been added reads, "To use the advantage of a salaried position to compete unfairly with other enginers."

At the University of Florida the faculty and staff members are encouraged to engage in research; to offer professional advice concerning the development of any national resources of the state, or any new product, scientific apparatus, or process; to prepare and publish the results of their researches in articles and reports; and to serve as officers and members of important committees of scientific societies and organizations. Outside employment there is subject to the restrictions that it shall in no way cause the violation of any obligation to the university; that such employment shall be of such character that it will not embarrass the university or prejudice it in public opinion; that the connection with the university shall not be used to advertise rival commercial products; that such work shall not be solicited or involve the employee in any direct controversial competition with established industries or professions, unless the work is clearly for the public good; that routine work having little or no value other than remuneration be discouraged; and that when older members of the staff engage in outside work, it should be in an advisory, analytical, or consultative capacity, or calculated to freshen the mind, stimulate breadth of view, promote creative thinking or better teaching or research.

Across the continent, at the University of California, members of the staff are prohibited from soliciting outside employment, but they are encouraged to engage in the practice of their profession so far as may be necessary to maintain professional competency. Such activities, however, are to be conducted under private arrangements and for such fees as prevail in general practice. Routine tasks of a commonplace type undertaken primarily to supplement personal income are not approved. University participation in tests and investigations is limited to those activities which extend knowledge or increase teaching effectiveness. Reports of the essential data and results of all such laboratory work are filed with the university and may be published by it. University laboratories are not available for routine tests of a purely commercial character unless it is conclusively shown that satisfactory facilities for these tests do not exist elsewhere. Commercial tests involving controversial elements are not to be undertaken except at the direct and unanimous request of representatives of all the parties to the controversy. Members of the staff above the rank of assistant professor may not receive any extra compensation for participation in tests and investigations undertaken by the university unless the work is conducted during vacation periods.

At the University of Michigan, teachers of engineering subjects are encouraged to engage in professional activity outside their university work in so far as it can add to the effectiveness of their work as teachers and does not impair their service to the university. Where the work relates to problems of public interest, the special kinds of skill available in the staff are, as far as possible, made available to the public. Such work should be secured because of the particular talents of the man and not because of his connection with the university. A teacher's desire to engage in work outside his university duties may not be inspired primarily by any spirit of commercialism.

E.C.P.D. to Accredit Engineering Colleges

ALL the bodies participating in the Engineers' Council for Professional Development have conferred their approval on it as the regularly constituted agency for accrediting engineering colleges. These participating bodies are: the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Society for the Promotion of Engineering Education, the National Council of State Boards of Engineering Examiners.

Through its Committee on Engineering Schools, the E.C.P.D. announces the following principles and procedures in accordance with which accrediting will be conducted:

BASIS FOR ACCREDITING

I. Purpose of accrediting shall be to identify those institutions which offer professional curricula in engineering worthy of recognition as such.

II. Accrediting shall apply only to those curricula which lead to degrees.

III. Both undergraduate and graduate curricula shall be accredited.

IV. Curricula in each institution shall be accredited individually. For this purpose, the E.C.P.D. will recognize the six major curricula—Chemical, Civil, Electrical, Mechanical, Metallurgical, and Mining Engineering—represented in its own organization and such other curricula as are warranted by the educational and industrial conditions pertaining to them.

V. Curricula shall be accredited on the basis of both qualitative and quantitative criteria.

VI. Qualitative criteria shall be evaluated through visits of inspection by a committee or committees of qualified individuals representing the E.C.P.D. The visits of inspection either as to entire institutions or as to specific curricula may be waived at the discretion of the Council.

VII. Quantitative criteria shall be evaluated through data secured from catalogs and other publications, and from questionnaires.

VIII. Qualitative criteria shall include the following:

1. Qualifications, experience, intellectual interests, attainments and professional productivity of members of the faculty.
2. Standards and quality of instructions:
   a) In the engineering departments.
   b) In the scientific and other cooperating departments in which engineering students receive instructions.
3. Scholastic work of students.
4. Records of graduates both in graduate study and in practice.
5. Attitude and policy of administration toward its engineering division and toward teaching, research, and scholarly production.

IX. Quantitative criteria shall include the following:

1. Auspices, control, and organization of the institution and of the engineering division.
2. Curricula offered and degrees conferred.
3. Age of the institution and of the individual curricula.
4. Basis of and requirements for admission of students.
5. Number enrolled:
   a) in the engineering college of division as a whole.
   b) in the individual curricula.
6. Graduation requirements.
7. Teaching staff and teaching loads.
8. Physical facilities, the educational plant devoted to engineering education.
9. Finances: investments, expenditures, sources of income.

A COORDINATED EFFORT

The purpose of the E.C.P.D. is to substitute a single accrediting process for the uncoordinated methods that have been used in the past. Since it represents the national engineering societies, the state licensing boards, and the colleges of engineering, the E.C.P.D. is the only agency that can accredit colleges under properly inclusive auspices. As an important incidental advantage, accrediting by this one agency will avoid the needless duplications of present procedures.

The Council is merely authorized by its constituent organizations to publish a list of accredited colleges for use by those agencies that require such a list. It has no authority to impose any restrictions or standardizations on engineering colleges, nor does it desire to do so. On the contrary, it aims to preserve the independence of action of individual institutions and to promote the general advancement of engineering education thereby.

As stated in the foregoing paragraphs headed "Basis of Accrediting," appraisal of institutions will be based on statistical information as obtained from catalogs and questionnaires, and on evidence of quality of instruction, adequacy of equipment and of teaching staff, and other factors not susceptible of statistical analysis, as determined by visits of inspection by committees of qualified representatives of the Committee on Engineering Schools. Emphasis will be given to quality of work rather than to statistical information to a greater degree than in former accrediting procedures. No hard-and-fast prescriptions are laid down for the curriculum, the physical facilities, the investment or expenditures, or other specific points relating to a given institution, though all of these, and others, will be taken into account in appraising the institution as a whole. Final decision as to accrediting of each institution rests with the Engineers' Council, which will pass on the recommendations made to it by the Committee on Engineering Schools.

The general expenses of developing the accrediting program will be borne in part by a grant of funds from the Engineering Foundation. Expenses of the visiting committees representing the Council will be met by a charge made to the individual institutions sufficient to cover cost of travel and subsistence during the inspection. This is in accord with the practice of certain other accrediting agencies.

Committees of inspection will comprise both teachers and practicing engineers, the criteria for selection being competency to judge educational institutions, good judgment, and availability. For the purposes of organization and administration of the accrediting program, the country has been divided into seven geographical regions, which include within their boundaries approximately equal numbers of engineering colleges: New England; the Middle Atlantic States and Maryland; the Southeastern States; the Upper Mississippi Valley; the Lower Mississippi Valley; the Southwest; and the Northwest. Committees in each of the seven geographic areas will include representatives of each of the organizations constituting the Engineers' Council. Alternates will be provided who will serve instead of the regular members when the latter would be called upon to judge a neighboring or rival institution, or the one with which the individual himself is connected. A member of Council's Committee on Engineering Schools will serve as chairman of each regional committee.

Accrediting of individual institutions and of curricula offered by them will be, of course, on invitation of the institution. Formal notification of the launching of the accrediting program will be sent by the committee to officials of the institutions in the near future.

The membership of the E.C.P.D. Committee comprises the following individuals:

Karl T. Compton, Massachusetts Institute of Technology, Chairman, representing the American Institute of Electrical Engineers

H. P. Hammond, M. Am. Soc. C.E., Polytechnic Institute of Brooklyn, Vice-Chairman, representing the Society for the Promotion of Engineering Education

G. M. Butler, University of Arizona, representing the American Institute of Mining and Metallurgical Engineers

Ivan C. Crawford, M. Am. Soc. C.E., University of Idaho, representing the American Society of Civil Engineers

Harry A. Curtis, Tennessee Valley Authority, representing the American Institute of Chemical Engineers

P. H. Daggett, Rutgers University, representing the National Council of State Boards of Engineering Examiners

A. A. Potter, Purdue University, representing the American Society of Mechanical Engineers.

Inquiries as to any phase of accrediting should be addressed to the Committee on Engineering Schools, the Engineers' Council for Professional Development, George T. Seabury, Secretary, 33 West 39th Street, New York, N.Y.

Activities of Student Chapters

IN THE report of the Society's Committee on Student Chapters to the Board of Direction for the academic year 1933–1934, there are some interesting data. Reports were received from 104 out of 109 Student Chapters and from 86 faculty advisers. Of the nearly 4,000 students affiliated with these Chapters, 42 per cent were seniors, 33 per cent juniors, and 14 per cent sophomores. The total attendance at 1,250 Chapter meetings held during the period exceeded 40,000, an average attendance of 32. Papers or lectures were given at these meetings by 800 students, 175 faculty members, and 380 practicing engineers. The illustrated lectures furnished by the Society were used on 210 occasions. The membership in Student Chapters is gratifyingly high, and the fact that the attendance at meetings averaged 84 per cent of the membership—a surprisingly good record—indicates a healthy student interest in the Society and its work.

One Chapter was reestablished in July 1934, at the University of Mississippi, and because of the consolidation of colleges, the Student Chapter at the University of Georgia was abandoned. At its meeting on January 14, 1935, the Board of Direction acted favorably on the application for a Student Chapter at the Utah State Agricultural College, bringing the total number of Student Chapters up to 111 as of that date.

"Proceedings" Discussion Demonstrates Problem of Scope

PUBLICATION in the December PROCEEDINGS of a paper by T. Y. Lin, Jun. Am. Soc. C.E., entitled "A Direct Method of Moment Distribution," has precipitated a veritable avalanche of discussions, most of which attempt to establish a prior concept of this "method." Quite aside from the fact that the technical TRANSACTIONS of the Society cannot be opened for the trial of cases of this kind (since they involve personalities) it is a serious question: first, whether a "modification" of the Cross method can itself be termed a method; and second, whether the Lin paper may not antedate many of the "modifications" claiming priority on the basis of the publication date of the Lin paper, which has been on a long-deferred publication schedule.

In justice to Mr. Lin, it should be stated that his original manuscript called attention to the similarity of a number of methods in this field of structural analysis. This reference was deleted before publication in PROCEEDINGS in order definitely to restrict the scope of discussion to that of a single phase of an exceedingly broad field. It is contemplated that Mr. Lin will summarize the question of similarity of methods in his closing discussion. In the meantime it is hoped that discussers will confine themselves to the technical merits and defects of the Lin paper as published, maintaining this subject foremost and referring only to parallel modifications (without trying to establish personal priority of concept) when such references are necessary as "exhibits" to strengthen an argument.

The primary purpose of PROCEEDINGS is to provide a medium in which members can "air their views" concerning proposed advances in the civil engineering profession. Ordinarily the space accorded for this purpose is more liberal than in almost any other similar publication. Regardless of rank in the profession or relative age or degree of criticism offered, discussers are welcomed without stint in PROCEEDINGS provided only that they avoid personalities and keep the topic under discussion "in the center of the stage."

Boundaries of Society Districts and Zones Unchanged

IN ORDER that the Corporate Members of the Society may be prepared to indicate their choice of nominees for forthcoming vacancies among the Society officers, it is customary to announce, soon after the beginning of the year, any change in the boundaries of the Districts and Zones that will be represented by the Directors and Vice-Presidents. The Constitution provides that such announcement be made "not later than April 1 in each year."

The Committee on Districts and Zones, after due consideration, has recommended that no change be made in the boundaries for the current year. This recommendation was adopted by the Board of Direction at its meeting on January 14, 1935. Full announcement of the existing division into both Districts and Zones will accompany the First Ballot when it is mailed to the Corporate Members in June. In the meantime, it is of interest to know that the geographical allocation of the membership is to remain the same as in the past two years, that is, since the creation of the new District, No. 16.

Members Exempt from Dues

LISTS OF Corporate Members exempt from payment of Society dues were published in the January 1933 and March 1934 issues of CIVIL ENGINEERING. Members are awarded this distinction either because they have paid dues continuously for 35 years, or because, having reached the age of 70, they have paid dues continuously for 25 years. The whole group of members thus privileged is listed in the *Year Book*, pages 103–106 of the 1934 edition. During the past year others met the constitutional requirements in this respect, and on January 1, 1935, also became exempt from dues. The following names should now be added to the list of exemptions:

Adam, Robert
Alford, William Valorus
Allin, Thomas David
Bailey, William Melvin
Barbour, Frank Alexander
Basinger, James Garnett
Betts, Romeo Thompson
Booth, Arthur Allen
Bowne, William Hunt
Brown, Baxter Lamont
Brown, Thane Ross
Budge, Edward Barnard
Butler, George
Chase, Charles Francis
Chase, Richard Davenport
Childs, Oliver W.
Coates, Frank Raymond
Collier, Bryan Cheves
Comstock, Charles Worthington
Cory, Harry Thomas
Coverdale, William Hugh
Davis, William Russell
Dixon, Charles Young
Dockweiler, John Henry
Edwards, Warrick Rigeley
Evans, Peter Platter
Fish, John Charles Lounsbury
French, Arthur Willard
Fritch, Louis Charlton
Gaston, Louis Prevost
Gerry, Martin Hughes, Jr.
Gester, William Burr
Glasgow, Arthur Graham
Griffith, Lawrence
Grimes, Edwin Lincoln
Gutelius, Frederick Passmore
Haas, Edward Francis
Hallihan, John Philip
Hammatt, William Cushing
Harris, Stephen
Harroun, Philip Embury
Harte, Charles Rufus
Harwood, Thomas Triplett Hunter
Hayes, Stanley Wolcott
Hewett, William Sherman
Holt, Arthur Grant
Horton, Theodore
Houston, Gavin Nelson
Hubbell, Clarence William
Hubbell, George Scott
Humphreys, Clifton Stewart
Huston, Tillinghast L'Hommedieu
James, William Atlee
Janney, Thomas Gordon
Johnson, Rankin
Jonah, Frank Gilbert
Kahn, Julius
Keller, Charles
Kinnear, Wilson Sherman
Knickerbacker, John
Lambert, Wallace Corliss
Lang, Otto Heinrich
Larsson, Carl Gustaf Emil
Latta, Harrison Wainwright
Leeper, John Bigger
Legaér, Balie Peyton
Leonard, John Buck
Lowinson, Oscar
Lyon, Léon Élie
McCaustland, Elmer James
McMorris, Daniel Webster
Maloney, James Edward
Matthes, Gerard Hendrik
Mitchell, Samuel Phillips
Moisseiff, Leon Solomon
Moss, Robert Edward
Nichols, Charles Henry
Parker, Charles Jeremiah
Pharr, Harry Nelson
Reed, Wendell Monroe
Reynolds, Justin Oakley
Rosenberg, Theodore
Sando, Will Joseph
Sax, Percival Mosley
Schick, James Reese
Shellenberger, Leidy Rudy
Sherman, Charles Winslow
Simpson, George
Strouse, William Franklin
Stuart, James Lyall
Sturtevant, Carleton William
Toch, Maximilian
Tonkin Thomas, Juan
Vail, Charles Davis
Van Alstyne, Henry Arthur
Williams, John Norman Spencer
Wilson, Charles William Schrage
Woods, Robert Patterson
Young, Roscoe Cyprian
Zinn, Aaron Stanton

The active support that these men have given the Society for the 25- or 35-year period, according to their age, is indicative of what their association with the Society must have meant to them.

Preview of Proceedings

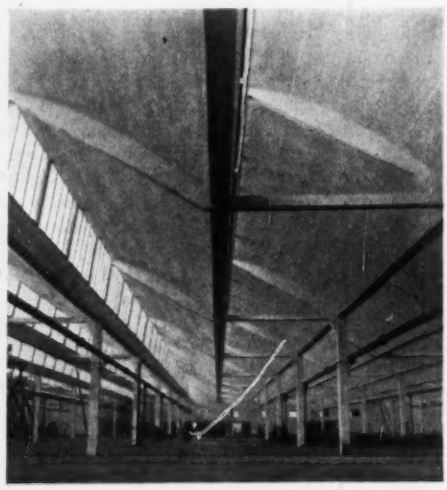
Several interesting papers have been scheduled for the March issue of PROCEEDINGS. *The two main papers will deal with the subjects of line-load action on thin cylindrical shells and the underground corrosion of pipe lines. Progress reports of the Committee of the Structural Division on Masonry and Reinforced Concrete and of the Committee of the Sanitary Engineering Division will also appear in this issue.*

LINE LOAD ACTION ON THIN CYLINDRICAL SHELLS

A FORTHCOMING paper by Herman Schorer, Assoc. M. Am. Soc. C.E., on "Line Load Action on Thin Cylindrical Shells" is a logical sequel to his previous paper, "Design of Large Pipe Lines," which was published in TRANSACTIONS for 1932, Vol. 98. In his earlier paper, Mr. Schorer demonstrated that a pipe completely filled with liquid is subject to two sets of stresses: first, those tending to keep the cross section of the pipe circular, combined with longitudinal beam stresses, and second, the rim stresses that act over a short zone in the vicinity of the supporting rings.

When the pipe is partly full, a third set of stresses occurs in the pipe shell causing discontinuity of the load at the liquid level. The case of a barrel or vaulted type of roof structure in which the upper half of a cylindrical shell rests upon supporting end walls is an extension of this theory, in that the reactions on the longitudinal edge produce stresses throughout the structure, in addition to those that would occur if the roof were regarded as a part of a pipe supported and stiffened at the end only. In his paper scheduled for the March issue of PROCEEDINGS, Mr. Schorer introduces the logic and equations necessary to analyze this third system of stresses, namely, those produced by loads applied along the longitudinal edges of the cylinder. He does that by deriving "influence numbers" for the longitudinal edge deformations of a thin cylindrical shell sector fixed rigidly between transverse stiffening members. The monolithic action of the longitudinal stiffening members as well as the analysis of discontinuous surface loads leads to the consideration of corrective line loads, which restore the continuity of the structure.

In an example at the end of the paper, Mr. Schorer investigates the secondary stress condition in a pipe half filled with water. Interesting in this connection are the accompanying views of the barrel and butterfly types of roof.



A "SAWTOOTH TYPE" OF ROOF IN A TEXTILE PLANT IN ARGENTINA

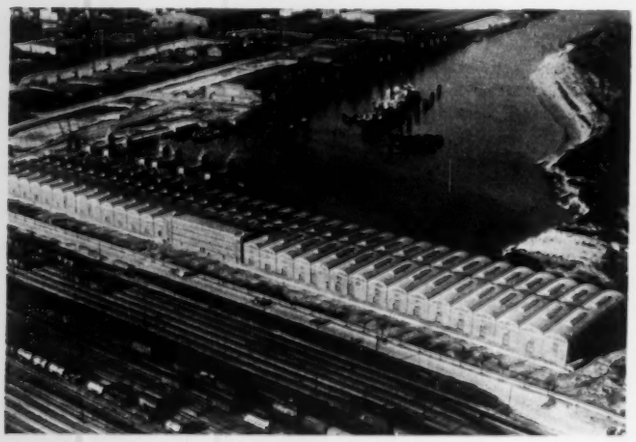
UNDERGROUND CORROSION

THE SUBJECT of underground corrosion of pipe lines, which has been treated by K. H. Logan in an article scheduled for the March issue of PROCEEDINGS, is of growing economic importance. Corporations owning pipe lines are spending considerable sums in the study of this problem. The Cast-Iron Pipe Research Association was organized in 1927. The American Petroleum Institute has founded a Committee on Pipe Line Corrosion and, since early in 1928, has employed a research engineer to investigate methods of reducing underground corrosion losses. In 1929, the American Gas Association took similar action. And at the annual meetings of the two latter associations at least one, and usually several papers, dealing with corrosion are presented. Occasionally, the subject is also presented at a meeting of the American Water Works Association or the New England Water Works Association.

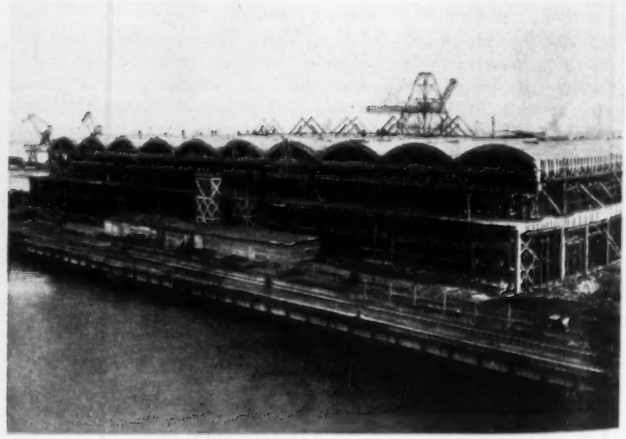
In various parts of the United States, companies operating gas or oil lines employ one or more men who devote their entire time to corrosion problems. Several companies maintain well-equipped laboratories and staffs of technical men to study such problems and to advise their construction and maintenance men regarding the methods of minimizing corrosion losses. In fact, throughout the country executives are authorizing considerable expenditures for corrosion research, and this is perhaps the best evidence of the seriousness of the problem.

The paper by Mr. Logan is a precise résumé of the activities of the National Bureau of Standards in this field. The bureau has been studying various forms of underground corrosion since 1911. In 1928, 1930, and 1933, conferences on underground corrosion were held at the Bureau of Standards, and at each of these sessions from 30 to 40 papers dealing with this subject were presented and discussed. The conferences have been attended by men from widely scattered sections of the United States, and contributions have been received from foreign countries. In 1933 the Underground Corrosion Section of the bureau had as guests representatives from Japan and Russia and had visits from engineers from several other countries.

The forthcoming paper discusses the characteristics and causes of underground corrosion, the means of reducing losses due to such corrosion, and the need for further research in this field. A brief but valuable bibliography on the literature of the subject is appended.



Dock Shed in Hamburg



Dock Shed in Gdingen

ZEISS—DYWIDAG TYPE OF DOCK CONSTRUCTION IN GERMANY

PROGRESS REPORT OF THE COMMITTEE OF THE STRUCTURAL DIVISION ON MASONRY AND REINFORCED CONCRETE

AT THE Annual Meeting of the Society on January 17, 1935, the Committee of the Structural Division on Masonry and Reinforced Concrete submitted a Progress Report, which was in effect a compilation of reports of the following six subcommittees: Subcommittee A on the Design of Ridges and Corners in Reinforced Concrete; Subcommittee B on Reinforced Concrete Frames Under Wind Loads; Subcommittee C on the Influence Upon Structural Design of Volume Changes and Plastic Flow in Concrete; Subcommittee D on Reinforced Concrete Columns; Subcommittee E on Reinforced Concrete Slabs Supported on Four Sides; and Subcommittee F on Moment Coefficient for Irregular Types on Flat Slabs.

The forthcoming Progress Report describes fully the advances made by Subcommittees C and F. An important function of these subcommittees is to find existing information available in the field of masonry and reinforced concrete and to make that information more easily available to the designer. The original Progress Report contained tables of tentative coefficients for determining final end moments resisted in flat slab sections; but the report as submitted at the Annual Meeting was greatly condensed. In its published form it is still condensed, although considerable material has been added to it. Those who are interested in this subject may correspond directly with the chairman of the committee.

WATER SUPPLY ENGINEERING: PROGRESS REPORT OF COMMITTEE OF SANITARY ENGINEERING DIVISION

IN THE "Preview of Proceedings" for December and subsequently, in the December issue of PROCEEDINGS, descriptions were given of the work of the Committee of the Sanitary Engineering Division during the years 1932 and 1933. The forthcoming progress report, logically, might have been published as a third part of that report. Unfortunately, it could not be made available in time.

The forthcoming report, which covers the year 1934, deals with current progress in the development of materials and methods of constructing dams and other water-supply structures. Among the subjects considered are new processes for lining pipe lines in place, measuring tastes and odors in water, sterilizing water, controlling the growth of weeds, and preventing corrosion in pipes. The other problems that are discussed represent an advance in the understanding of problems of water hammer and friction coefficients.

Program of Public Education Planned

DURING 1934 the Society's Committee on Public Education met several times in an effort to determine the relative merits of various efforts to disseminate technical information to the general public. Activities were concentrated on three fronts: radio broadcasting, controlled newspaper releases, and circularization of educational material to Local Sections and to the public.

In carrying out this program two radio talks were broadcast, one in July by D. H. Sawyer, M. Am. Soc. C.E., and one in August by Abel Wolman, M. Am. Soc. C.E. The cooperation of *Science Service*, Washington, D.C., made these broadcasts possible. The committee recommended that this method be continued and expanded during 1935.

Through the Associated Press, a journalistic revision of a technical paper by R. S. Patton, M. Am. Soc. C.E., was released to the newspapers on November 5, 1934, and a technical summary was broadcast by radio over a nation-wide network on November 4. Results, which were measured by obtaining the services of a newspaper clipping bureau, proved so satisfactory that this method is to be continued during 1935.

Although the circularization of technical material to Local Sections and to the public direct appears to be highly desirable, the work necessary to make it a success is great. Timely material must be prepared continuously by a permanent agency. To accomplish this phase of public educational work, the Board of Direction at its meeting on January 14, 1935, authorized the initiation of a program of publicity by a qualified expert.

Increasing Junior Member Activities

A REPORT of the Society's Committee on Juniors was rendered to the Board of Direction at its meeting on January 14, 1935. In this report the committee mentioned three handicaps preventing the Juniors of the Society from taking a larger part in Society activities. Juniors are generally so employed that they cannot attend the meetings of the Society because of lack either of time or of funds. Also, they often feel that the interests of the older members do not include the interests of those just entering the profession and that they may be out of place in a meeting of the older engineers. And further, they have not been made to understand the advantages that will accrue to them through Society and committee activities and have not been given the opportunity to prove their worth along these lines.

To correct some of these conditions the committee has recommended that an active effort be made by the Society and the Local Sections to bring Juniors into closer contact with Society affairs. To accomplish this end, it was suggested that as far as possible a Junior be appointed to each committee of the Society and of the Local Sections; that each Local Section have an active Committee on Juniors; and that at least one paper at each Local Section meeting be presented by a Junior.

Constructive suggestions for bringing Juniors into closer touch with the Society, from members both Junior and Corporate, will be welcomed by the committee.

Library Translations Available

ENGINEERS and technical men in all parts of the country can call on the Service Bureau of the Engineering Societies Library for exact, technically accurate translations, assured that in this way they will obtain the services of a well-equipped staff, which can handle translations from any language and on any aspect of engineering.

In a five-year period the Service Bureau has translated more than 2,750,000 words from many languages. Translations from German are the most frequent and make up about half the total, but those from French, Italian, Spanish, Russian, and other languages are often requested.

In addition, the Service Bureau has on hand in its files a collection of more than 1,500 translations that may be obtained by paying a moderate charge for revision and copying. Charges are low because they cover only the actual expense of doing the work. Inquiries regarding them should be addressed to the Engineering Societies Library, 29 West 39th Street, New York, N.Y.

News of Local Sections

BUFFALO SECTION

The regular monthly meeting of the Buffalo Section was held on January 22 at the Buffalo Athletic Club. At this session Raymond E. Winfield, director of the Buffalo District of the Federal Housing Administration, gave an interesting talk on "Long Term Financing of Homes Under Title II of the National Housing Act." There were 17 members present at the meeting.

CENTRAL ILLINOIS SECTION

The Central Illinois Section held a meeting on January 11 in Champaign, Ill. The speaker of the occasion was Prof. M. H. Hunter, of the Department of Economics at the University of

Illinois. He chose as his topic, "Implications of the Federal Public Works Program," and a spirited discussion followed the address. The meeting was attended by 32 members and guests.

CENTRAL OHIO SECTION

At a meeting held on December 13, the Central Ohio Section elected the following officers for 1935: R. T. Regester, president; P. M. Holmes, first vice-president; T. W. Brannan, second vice-president; and C. W. Allen, secretary-treasurer.

CLEVELAND SECTION

A dinner meeting of the Cleveland Section was held on January 8 at the Chamber of Commerce Club. There were 44 members and guests present, and the speaker of the evening was Frederic E. Ayer, Dean of Engineering of the University of Akron, who gave an entertaining talk on the "Engineer in Utopia."

COLORADO SECTION

There were 63 present at a meeting of the Colorado Section held on January 14 at the Olin Hotel. After a business session M. C. Hinderlider discussed the features and plans of the Caddoa Reservoir and Dam, and H. C. Vidal, who is an associate consul for the Arkansas Valley Ditch Association in the suit with Kansas, commented on the project from the legal viewpoint. Numerous questions and discussions followed the lectures.

DAYTON SECTION

At a recent meeting of the Dayton Section, the following officers were elected for the coming year: W. E. Keyser, president; and C. H. Stephens, secretary-treasurer.

DISTRICT OF COLUMBIA SECTION

The following officers for 1935 were elected by the District of Columbia Section at a meeting on February 2, held at the Washington Hotel: R. C. Marshall, Jr., president; C. G. Paulsen, vice-president; and Medford T. Thomson, secretary-treasurer.

DULUTH SECTION

The Duluth Section, at a meeting on January 21, elected the following officers for 1935: A. C. Giesecke, president; John Carson, first vice-president; George W. Deibler, second vice-president; Wm. E. Hawley, secretary.

GEORGIA SECTION

A meeting of the Georgia Section was held on January 7. The speaker of the occasion was C. D. Gibson, Professor of Geology at Georgia School of Technology, who gave an illuminating talk on seismography.

METROPOLITAN SECTION

At a meeting of the Metropolitan Section held in the Engineering Societies Building in New York, N.Y., on February 18, the 500 members and guests present showed intense interest in the symposium on "The Relation of the Government to the Engineer." The first speaker, D. B. Steinman, decried the cut-throat competition among practicing engineers in government work and the present methods that are forcing the regimentation of the profession. Then J. P. H. Perry spoke, from his experience as assistant director of the Works Division of the Emergency Relief Administration, of the not too enviable position of the professional engineer in that work. H. M. Waite, of Cincinnati, rounded out the symposium by speaking on the subject, "The Government, our Largest Employer of Engineers on Public Works." The active discussion that ensued resulted in the unanimous passage of a resolution urging that, in the expenditure of the four billion dollars now under discussion in Congress, private engineering enterprise be utilized. Refreshments were served at the close of the meeting.

MILWAUKEE SECTION

On December 20 the Milwaukee Section held a meeting at the City Club. There were 40 members and guests present, and Louis R. Howson addressed the meeting on "An Engineer's Bird's-eye View of Alaska." During the business session the following officers were elected for the coming year: W. A. Peirce, president; H. C. Webster, first vice-president; E. L. Knebes, second vice-president; and F. W. Ullius, secretary-treasurer.

NEW MEXICO SECTION

The New Mexico Section held its regular fall meeting at Santa Fe on September 19. Officers elected at that time to fill vacancies were as follows: Berkeley Johnson, first vice-president; J. H. Dorroh, second vice-president; and A. N. Thompson, secretary-treasurer. The address of the evening was delivered by S. T. de Boer, Planning Consultant for the state organization of the National Resources Board, who spoke on the problems and the work of this board.

NORTHWESTERN SECTION

On January 24 the Northwestern Section held a meeting at which J. G. Tripp, vice-president of the Merritt, Chapman and Whitney Corporation, was the featured speaker. The subject of his address was "The PWA, the NRA, the NSR, and Their Effect on Contractors and Contracting."

NORTH CAROLINA SECTION

The North Carolina Section held a technical meeting on January 26 at the Sir Walter Hotel in Raleigh, N.C. Various business matters were discussed at this session, and several committees were announced.

PHILADELPHIA SECTION

There were 92 members and guests attending the meeting of the Philadelphia Section on December 19 at the Engineers Club. Carlton S. Proctor spoke on "Heavy Foundations," and an interesting discussion followed the address.

PORTLAND (ORE.) SECTION

The Annual Meeting of the Portland (Ore.) Section was held on January 4 with 66 attending. Officers were elected for the coming year as follows: Lyman Griswold, president; G. H. Canfield, second vice-president; and Carl E. Green, secretary. J. H. Polhemus continues as first vice-president, and Geary Kimbrell, as treasurer. After the business session, D. C. Henny spoke on a large land reclamation project in Holland and on various dam projects in the United States.

PUERTO RICO SECTION

On December 11 the Puerto Rico Section held its annual meeting, at which officers for 1935 were elected as follows: Reinaldo Ramirez, president; Rafael A. Gonzalez, vice-president; Ricardo Skerrett, vice-president; and Antonio S. Romero, secretary-treasurer.

ROCHESTER SECTION

The Rochester Section elected officers for 1935 at its annual meeting held on January 3. The results of this election were as follows: C. E. Elmendorf, president; C. F. Starr, first vice-president; and George C. Wright, second vice-president. The present secretary-treasurer, W. H. Roberts, will continue in office for another year.

SAN DIEGO SECTION

At the annual meeting of the San Diego Section held on December 27, the following officers were elected for 1935: F. D. Pyle, president; Edwin A. Ingham, vice-president; and C. W. Capwell, secretary-treasurer.

The San Diego Section held a meeting on January 24 at the Churchill Hotel. During this session H. W. Jorgensen, city engineer of San Diego, spoke on the sewerage and drainage problems of the city, covering both the financial and the engineering aspects of the problem. Then E. A. Ingham, city manager of Coronado, described similar problems, which he had encountered in that city.

SAN FRANCISCO SECTION

At a meeting of the San Francisco Section, held on December 18 at the Engineers Club, the following officers were elected for 1935: Charles G. Hyde, president; H. J. Brunnier, vice-president; and T. J. Corwin, secretary-treasurer. After the business session W. F. Durand gave an address on the topic, "Airplane Performance."

SEATTLE SECTION

The Seattle Section held a meeting on January 18 and elected the following officers for the coming year: Thomas Dewick Hunt, president; Robert Philip Howell, vice-president; and Miles E. Clark, secretary-treasurer.

SOUTH CAROLINA SECTION

On January 3 the South Carolina Section held its annual meeting, at which officers for the coming year were elected as follows: Robert L. Sumwalt, president; James H. Dingle, vice-president; and Albert E. Johnson, secretary-treasurer.

TACOMA SECTION

The Tacoma Section has elected officers for 1935 as follows: Glenn L. Parker, president; John P. Hart, vice-president; and Oscar H. Hallberg, secretary-treasurer.

UTAH SECTION

At a meeting of the Utah Section, held on January 18 in Salt Lake City, the following officers were elected for 1935: F. M. Allen, president; K. C. Wright, first vice-president; O. C. Lockhart, second vice-president; and F. H. Richardson, secretary-treasurer.

VIRGINIA SECTION

The fall meeting of the Virginia Section was held on November 9 at the Hotel Roanoke in Roanoke, Va. During the short business session held in the morning E. M. Hastings spoke of the work being done by Student Chapters, and R. B. H. Begg, of Virginia Polytechnic Institute, described surveying activities in Virginia under the FERA. Among the speakers heard at the conclusion of the business meeting were E. B. Norris, of Virginia Polytechnic Institute, and F. W. Scheidenhelm, a consulting engineer of New York, N.Y. The after-luncheon speaker was Graham Claytor, vice-president of the Appalachian Electric Power Company. The afternoon was given over to inspection trips, which included various points of local interest.

The annual meeting of the Virginia Section was held on February 1 in Richmond, Va. The members and their guests inspected the city water terminal and then went by boat down the James River to view the work that is being done in building a deep-water terminal at Richmond. During the business session the following officers were elected: R. Keith Compton, president; and W. D. Tyler, C. W. Ogden, and W. T. Howe, vice-presidents.

Student Chapter News

CORNELL UNIVERSITY

The first meeting of the season of the Cornell University Student Chapter was addressed by S. C. Hollister, new director of the School of Civil Engineering. His subject was Boulder Dam, for which project he is consulting engineer on the design of the penstocks, and his lecture was illustrated with moving pictures on all phases of the work. Over 200 attended the meeting.

DUKE UNIVERSITY

At its meeting on October 29, the Duke University Student Chapter heard an illustrated lecture on the "Conowingo Hydro-Electric Development," supplied by the Society and presented by one of the student members. Another society lecture on "The Cascade Tunnel" was read at a meeting on November 19. These informal lectures have proved of great interest to those attending the meetings.

LEWIS INSTITUTE

On November 3, 1934, a group of 21 from the Lewis Institute Student Chapter made an inspection trip to Dubuque, Iowa. Work in progress on the locks for the Mississippi canalization project was inspected at both Dubuque and Bellevue. The round-trip distance of some 330 miles was accomplished in a day, and the visit proved to be of great interest to all who participated.

GROUP FROM LEWIS INSTITUTE STUDENT CHAPTER INSPECTS MISSISSIPPI RIVER LOCK

RHODE ISLAND STATE COLLEGE

The second annual meeting of the Rhode Island State College Student Chapter was held as a joint meeting with the Providence Section of the Society on November 14. After supper the meeting was addressed by Raymond G. Bressler, president of the college, who spoke on "Plans for the Development of Rhode Island State College," and William S. Sloan, bridge engineer of the Rhode Island State Board of Public Roads, who gave an illustrated talk on "Bridge Maintenance, with Special Reference to the Rhode Island Stone Bridge."

ROSE POLYTECHNIC INSTITUTE

On October 21 the Rose Polytechnic Institute Student Chapter held its first meeting of the 1934–1935 school year. Luncheon was served at the home of Professor R. L. McCormick, and afterward the students listened to the Society's lantern lecture, "The Cascade Tunnel," presented by four of the seniors. The meeting was attended by 24 students and 3 professors, and the lecture proved both enjoyable and instructive.

WASHINGTON UNIVERSITY

For the occasion of Engineers' Day at the University of Washington, members of the Washington University Student Chapter erected a three-span bridge. In this structure, which was both designed and built by the students, the two approach spans were 25 ft long, and the center span, 50 ft long. The center span was mounted on a turntable for which an electric motor served as the turning unit.

Two Approach Spans 25 ft in Length; Center Span 50 ft in Length;

Close-Up of Center Span Mounted on Turntable

BRIDGE BUILT BY WASHINGTON UNIVERSITY STUDENT CHAPTER

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING for April

TO MAKE possible a generous treatment of the large number of papers presented at the Annual Meeting of the Society in New York, N.Y., January 16–19, two numbers of CIVIL ENGINEERING are being devoted to their publication in somewhat shortened form. In the present number are to be found the first group; the remaining articles are scheduled for April. The symposium on flood control and power developments in the Tennessee Valley, previously announced for March, was delayed and also will appear in April.

Triennial Prize of George Montefiore Foundation

ONCE every three years the George Montefiore Foundation, of Liége, Belgium, awards a prize to the best original paper submitted in an international competition on the scientific advancement of and progress in the technical application of electricity in all its branches. The prize for 1935 amounts to a total of 22,000 francs, a little over a thousand dollars. In special cases this may be divided by the jury, which is composed of ten electrical engineers, five Belgian and five foreign. Papers must be printed or typewritten in either French or English. Twelve copies of each paper must be submitted and sent postpaid to "M. le secrétaire-archiviste de la Fondation George Montefiore, Rue Saint-Gilles, 31, Liége (Belgique)."

The last date on which papers submitted in this competition will be received is April 30, 1935. Each paper must clearly bear the heading, "Travail soumis au concours de la Fondation George Montefiore, Session de 1935."

Boulder Dam Goes to Work

BOULDER DAM has gone to work. On February first the huge gates were closed and the normal flow of the Colorado River began to be stored behind the dam at the rate of 5,000 cu ft per sec. At this rate there will be enough water to begin the generation of power by the middle of 1935 and to supply the thousands of irrigators in Imperial Valley with adequate water for the next growing season. Although the power plant, which is now under construction, will not be complete until 1940, it is intended that some generators will be ready to supply power this year. Construction of Boulder Dam has been pushed rapidly as a part of the Public Works Administration program for the relief of unemployment. As a result, the storing of water in the reservoir has begun $2^1/_2$ years ahead of schedule.

It was forty years ago that water from the Colorado River was first diverted to irrigate the fertile lands lying in the Imperial Valley of California. In 1905, however, the river jumped its channel, lying high on its delta cone, and for weeks poured into the Salton Sea. It flooded crops and damaged property to the extent of $8,000,000 before engineers could turn it back to the original channel leading to the Gulf of California, into which it naturally empties.

The survey ordered by President Theodore Roosevelt at that time resulted 25 years later in the initiation of the Boulder Dam project. To date $94,660,000 has been appropriated for the structure. Work has progressed smoothly and rapidly, and since the summer of 1934 has continued day and night. The first yard of concrete was placed deep in the foundation of the dam on June 6, 1933. On February 22, 1935, the last of the 3,200,000 cu yd of concrete required to complete this, the largest dam yet raised by man, was poured. Records have been broken on every hand on this job, and superlatives must be used to describe almost every feature connected with both its design and its construction. It is indeed an engineering epic, an outstanding example of the highest development of the art produced to date.

Training Engineers for Public Service

TODAY many young engineers are entering public service work or are engaging in activities that bring them into close and regular contact with government authorities. Because of the growing importance of this relationship, a number of engineering schools and colleges are giving engineering students an opportunity to become better acquainted with government organization and procedure. This enables them to become familiar with the channels through which government work is initiated, promoted, and supervised and permits them to see the way in which regulating bodies function in planning and financing public works, determining assessment districts, floating bond issues, and levying taxation. At the California Institute of Technology a series of 12 lectures on these subjects is being given this year to fifth-year engineering students.

Beginning in September 1935, Purdue University is initiating an entirely new curriculum in Public Service Engineering, the main objective of which is the training of engineers to deal with the technologic problems of government. Sophomore students whose freshman records have indicated superior mentality and outstanding personality, and who show a decided interest in public matters are to be eligible for matriculation in this new Public Service Engineering curriculum.

For students interested in an engineering background for a law practice relating to public utilities, transportation, radio, or patents, Purdue University is also to offer in September 1935 a combined course in engineering and law. The student, after finishing three years of engineering, will transfer from Purdue to the School of Law at Indiana University. After the successful completion of one year there he will receive the degree of B.S. in Engineering Law from Purdue University. For the completion of two additional years of law work, the LL.B. degree will be conferred by Indiana University.

These adjustments in engineering curricula to meet the demand for trained engineers in public service work and in fields relating to government are evidences of the growing importance of the engineer to the public and to its agent, the government.

Influence and Responsibilities of Engineers

OBSERVATIONS of the president of a historic institution like Harvard University are usually worth attention, and particularly so when they deal with professional trends. President Conant, who is himself a scientist of note, makes the following comments in his report to his Board of Overseers:

"It seems clear that, whatever sort of social and economic order lies ahead of us, society will demand the luxuries and conveniences afforded by modern technology. There are certain to be engineers for generations to come, occupying positions of respect and importance in the community no matter what sort of social order we may have. These scientists may be in a strategic position of influence; much may depend on the way they look at life. It is conceivable that a type of society might arise in which there would be great material prosperity and a highly developed technology but no spiritual and intellectual freedom. Under such stifling conditions all vital interest in art and literature would fade and enthusiasm for pure thought would vanish; what would remain would be a barbarism which all the radios and automobiles and skyscrapers in the world would not conceal. In such a desert, the applied scientists, essential for a smooth operation of the complex mechanism, might be the only men with a true education. The monks in the Dark Ages preserved the remnants of one civilization to enable another to come to life. Perhaps, in some measure at some time, the scientist and engineer may have a similar challenge. Thus a heavy responsibility lies on the

shoulders of engineers and scientists and those who educate them. Today in many institutions we are developing men who understand not only their technical professions but also the needs and aspirations of the human spirit."

Readers of CIVIL ENGINEERING are indebted to Gavin Hadden, M. Am. Soc. C.E., for calling attention to these words.

Wide Variety of Steel Mill Products

TODAY steel is the universal metal. It is essential in hundreds of ways in our everyday life, and the products of the modern steel mill, ranging from skyscrapers to nail files, are put out in 100,000 different sizes, shapes, and finishes. According to the American Iron and Steel Institute, some of the more unusual steel products include beer-case nails, snake-fishing steel, safety-pin wire, and jail-bar steel. Even these types of goods are produced in many shapes and sizes. Thus, bobby-pin wire is manufactured in two shapes, eight thicknesses, seven widths, and four finishes; and hot rolled specialty strip steel comes in 462 varieties.

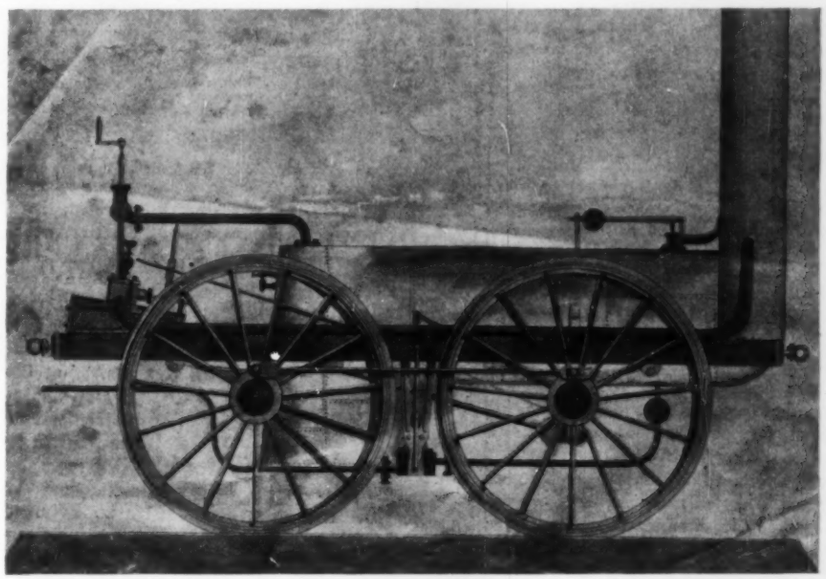
During the past year, the Institute points out, the greatest consumers of steel were the automobile, the container, and the building and railroad-equipment industries. This group used 53 per cent of all finished steel produced, of which 21 per cent went to the automotive industry alone. In order to satisfy this vast range of demands, the steel industry has a plant investment of $4,848,010,935.

Streamlined Steam Locomotive Completed

DESPITE recent developments in the use of other types of power, the New York Central Railroad evidently believes that the day of the steam locomotive is far from over. Acting on this view it has completed the first high-powered streamlined steam locomotive to be built. The new model is of the giant Hudson type for passenger trains and is enclosed in a streamlined hood shaped in accordance with the latest findings in aerodynamics. It is arranged to provide quick and easy access to the driving mechanism for inspection and oiling. The bell, the whistle, the smokestack, and all other projections that might offer resistance to the air have been depressed to or below the surface of the hood. Gases from the stack are lifted high above the train by air directed by wind scoops. At speeds of 70 to 90 mph the streamlined design is expected to reduce head air resistance by 35 per cent and effect a substantial saving in fuel cost. Its three pairs of 79-in. drivers are mounted on roller bearings.

In one of the accompanying illustrations the new locomotive, named for Commodore Vanderbilt who founded the railroad, stands beside the De Witt Clinton, the line's first locomotive, built in 1831. The former is 96 ft long, develops 4,075 hp, and weighs 228 tons. The latter is 23 1/2 ft long over-all, and weighs but 7 1/2 tons. The remarkable development of the steam locomotive during the past century is brought out by contrast. This photograph is reproduced by courtesy of R. E. Dougherty, M. Am. Soc. C.E., vice-president of the New York Central Lines.

One of the original wash drawings for the De Witt Clinton is also reproduced. According to the lettering on the drawing, this is "the third Locomotive Engine built for Actual Service on a Rail Road in the United States; made for John V. Jervis for Rail Road between Albany and Schenectady, A.D. 1831 by the West Point Foundry Association." Written in pencil on the drawing above the throttle but not distinguishable in the reproduction are the dimensions: wheel diameter, 4 ft 6 in.; distance from center to center of wheels, 5 ft 8 in.; length of frame, 11 ft 6 in.



ORIGINAL DRAWING OF THE "DE WITT CLINTON"
Reproduced from a Wash Drawing at Society Headquarters, New York, N.Y.

NEW YORK CENTRAL RAILROAD PLACES FIRST STREAMLINED STEAM LOCOMOTIVE IN SERVICE

Illustrations in CIVIL ENGINEERING

IT SHOULD be noted that the halftone and line-cut blocks used in Volume III of CIVIL ENGINEERING, that is, for the year 1933, are to be destroyed on April 1, 1935. Prior to that date, authors of articles appearing in this volume or others interested in any of the illustrations may obtain the original cuts by making application for them to Society Headquarters. There will be no charge other than the cost of forwarding the cuts by express or parcel post.

Requests will be filled in the order of receipt, except that first choice will be given to the authors of the articles in which the illustrations appear. Other cuts are also available, such as those used on the covers, on the pages of special interest, in the programs of Society Meetings, and in departmental items.

The cuts used in Volumes I and II have already been destroyed. Cuts from Volumes IV and V will be loaned to those making requests for them. However, such cuts must be returned when the desired use has been served.

Index to A.S.T.M. Standards Out

ENGINEERS will be interested to know that the yearly *Index to the American Society for Testing Materials Standards and Tentative Standards*, as of January 1, 1935, is now available. It indexes 730 specifications, test methods, recommended practices, and definitions on specific subjects in the field of engineering materials and the allied testing field. This 142-page pamphlet will be found helpful to the engineer in locating any of these items in the publications of the American Society of Testing Materials in which they appear. Copies of the index will be forwarded without charge to interested engineers who send requests to the headquarters of the American Society for Testing Materials, 260 South Broad Street, Philadelphia, Pa.

Unlicensed Surveyor Ousted from Elective Office

ACCORDING to a recent decision of the Supreme Court of Florida, a surveyor must be registered with the State Board of Engineering Examiners to hold elective engineering office in the state as well as to practice privately. In November 1932 a surveyor for Bay County was duly elected, whereupon the State Board of Engineering Examiners applied to the Attorney General of Florida, who instituted ouster proceedings against the incumbent, since he did not have a license to practice, as required by state law.

On December 12, 1934, Chief Justice Davis of the Florida Supreme Court handed down his decision disqualifying the defendant from holding office (State vs. Ward, 158 So. Reporter 273). The court held that an elected county surveyor without an engineering license is as unable personally to render legitimate service to the public as would be a county attorney who lacked the qualifications for practicing law in Florida. The office of county surveyor can be filled in a lawful manner only by a licensed practitioner. In this decision, the profession of surveying is defined as including the operation of finding and delineating the contours, dimensions, position, and topography of any part of the earth's surface or the preparation of a measured plan of any area, or road, showing the lengths directions, and contour of the land. The duties of a county surveyor, receiving an annual salary, include those of transitman and levelman, and the hiring of levelmen, rodmen, and chainmen.

This ouster decision of the Florida Supreme Court, coming two years after the county surveyor assumed office, raises the question of the validity of his official surveys during that period. In submitting this information, Horace H. Sears, M. Am. Soc. C.E., observes that Florida has decided that political success does not carry with it professional qualifications.

Another Engineering Monograph Out

FREQUENTLY manuscripts become available to the four Founder Societies, which the societies individually are unable to publish. In cooperation with a book publisher, a committee representing each society chooses for publication certain of these manuscripts which are considered to be of great value to the profession but which, because of limited appeal, probably could not be published on a strictly commercial basis. These books constitute the Engineering Societies Monographs. Thus members of the societies are enabled not only to obtain the books but to purchase them at a preferential rate. The Engineering Societies Library shares in the benefits of the venture, and the cooperating publisher is the McGraw-Hill Book Company.

The first monograph of the series, published in 1931, was *Plasticity* by Dr. A. Nadai. Since then four others have appeared. These are: *Hydraulics of Open Channels*, by B. A. Bakhmeteff, M. Am. Soc. C.E.; *Theory of Elasticity*, by S. Timoshenko; and *Fundamentals of Hydro- and Aero-Mechanics* and *Applied Hydro- and Aero-Mechanics*, written by O. G. Tietjens, based on his own work in Germany and on the lectures of L. Prandtl.

Now the sixth in the series is being published. This is *Elimination of Taste and Odor in Water*, by John R. Baylis, Assoc. M. Am. Soc. C.E. As its title suggests, the subject of this monograph is of special interest to water-works engineers—practical plant operators as well as students of sanitation. It gives the most extensive treatment of the characteristics of activated carbon yet published. For this study the author won the John M. Goodell Award of the American Water Works Association. The ammonia-chlorine treatment for the prevention of chlorinous tastes is covered fully, and other treatments for removing tastes and odors—such as super-chlorination, aeration, and ozone—are described in detail. Mr. Baylis's 22 years on the design, construction, and operation of water-filtration plants—and especially his past 8 years of experimentation in Chicago in working out the cheapest and most efficient means of purifying and removing the odors of natural and industrial origin in Lake Michigan water—have eminently fitted him for the work of preparing this authoritative volume.

This latest monograph is now on the presses and will be available to members of the Society until May 1, 1935, at the pre-publication price of $4. Orders will be filled after April 1, the date of publication, by the McGraw-Hill Book Company, 330 W 42d Street, New York, N.Y.

NEWS OF ENGINEERS

From Correspondence and Society Files

WILLIAM A. MEISSNER has been transferred from the Division Engineer's Office of the Lehigh Valley Railroad in Jersey City, N.J., to Picton and Oak Tree, N.J., where he will serve the same company in the position of engineer on grade-elimination projects.

EDWIN K. BORCHARD, previously associated with the Universal Atlas Cement Company, has accepted a position as technical manager for the Keystone Portland Cement Company, with offices in Philadelphia, New York, and Boston.

JOSEPH SORKIN has accepted a position as bridge designer with the Montana State Highway Commission with headquarters in Helena, Mont.

HOWARD R. HOUSER is now with the Frigidaire Division of the General Motors Corporation, Dayton, Ohio. He was formerly secretary of the Dayton (Ohio) Traffic Commission.

L. V. CLARK DEICHLER has resigned from the staff of Montgomery Ward and Company to accept an engineering connection with the Rutland Contracting Company, of Atlanta, Ga.

HARRY E. ECKLES has been appointed an assistant highway engineer in the Illinois Division of Highways, with headquarters in Springfield, Ill.

STEPHEN J. A. DERRY is now engaged in doing engineering work for the Pennsylvania State Emergency Relief Board, with offices in Pittsburgh, Pa. He was formerly a draftsman in the Pennsylvania Department of Highways.

PAUL BEERMANN, who was senior draftsman in the Bureau of Water Development of the City of San Diego, now has an engineering position in the Division of Development and Conservation of the Water Department of the same city.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From January 10 to February 9, 1935, Inclusive

Additions to Membership

Berndtson, Bernhardt Taylor (Jun. '34), Transitman, Shell Co., Martinez (Res., 1450 Alice St., Oakland), Calif.

Campbell, Thomas Herbert, Jr. (Jun. '34), College, Alaska.

Cole, Edward Shaw (Jun. '33), Care Pitometer Co., 50 Church St., New York, N.Y.

Cone, Victor Mann (M. '34), Senior Engr., U. S. Engrs., Memphis Dist., Box 97, Memphis, Tenn.

Cooper, Alfred Joseph, Jr. (Jun. '34), Junior Eng. Draftsman, Tennessee Val. Authority, 12th Floor, James Bldg., Chattanooga, Tenn.

Core, Edwin John (Jun. '34), With Soil Erosion Service, Dept. of Interior (Res., 624 Virginia Terrace), Santa Paula, Calif.

Cosgrove, Alan George (Jun. '34), Asst. Engr., Civ. Works Administration, U. S. Geological Survey, Water Resources Branch, Albany (Res., 12 One Hundred and Third St., Troy), N.Y.

Dougherty, John Wilson (Jun. '34), 5934 North Missouri Ave., Portland, Ore.

Douglas, Alexander William (Jun. '34), Engr. and Supt. of Constr., Works Div., Office of Boro Pres. of the Bronx, Highway Div. (Res., 1263 Park Ave.), New York, N.Y.

Dyer, Wesley Halliburton (Jun. '35), Estimator, Nashville Bridge Co., Nashville, Tenn.

Earnest, George Brooks (Assoc. M. '35), Instr., Civ. Eng., Case School of Applied Science, University Circle, Cleveland, Ohio.

Edwards, Coyle Vilmar (Jun. '34), Party Chf., U. S. Coast and Geodetic Survey, Donaldson, Ga.

Frierson, Robert Edward (Assoc. M. '34), Associate Civ. Engr., Tennessee Val. Authority (Res., 108 Raleigh St.), Knoxville, Tenn.

Fugate, Douglas Brown (Jun. '34), Instrumentman and Insp., State Dept. of Highways, Richmond (Res., Radford), Va.

Gaylord, Charles Nelson (Jun. '35), Instr., Steel and Concrete Design, Dept. of Building Constr., Hampton Inst., Box 139, Hampton, Va.

Gottlieb, William (Assoc. M. '34), Asst. Engr., Six Companies of California, Oakland (Res., 2519 Ridge Rd., Berkeley), Calif.

Gould, Maurice (Jun. '34), Draftsman, Dept. of Public Works, New York (Res., 1578 Sterling Pl., Brooklyn), N.Y.

Graves, Quintin Branson (Jun. '35), Instr., Univ. of Tennessee, Ferris Hall, Univ. of Tennessee, Knoxville, Tenn.

Gray, George Earley (Jun. '34), Junior Physical Testing Laboratory Aid, State Div. of Highways, Oakland (Res., 3214 College Ave., Berkeley), Calif.

Hawkins, Harold Vern (Jun. '34), 302 Bryant Ave., Ithaca, N.Y.

Herring, Vernon Maurice (Jun. '34), 3818 Woodbine Ave., Baltimore, Md.

Johnson, Edwin MacNeil (Jun. '34), 238 Senator Pl., Cincinnati, Ohio.

Jonas, Frederick (Jun. '35), 1123 Clay Ave., New York, N.Y.

Kennedy, Richard Roberts (Jun. '35), Designing Engr., Clyde C. Kennedy, 547 Call Bldg., San Francisco, Calif.

Kumpe, George (Jun. '35), 2d Lieut., Corps of Engrs., U.S.A., Holman 304, Mass. Inst. Tech., Cambridge, Mass.

Long, Horace Taggart (Jun. '34), Asst. Engr., U. S. Waterways Experiment Station, Box 665, Vicksburg, Miss.

Macabee, Lloyd Cedric (Assoc. M. '34), Deputy County Engr., San Mateo County (Res., 872 College Ave.), Menlo Park, Calif.

McMinn, Fred Francis (M. '35), Asst. Commr. of Buildings, City of Cincinnati, City Hall, Cincinnati, Ohio.

Morse, Reed Franklin (Assoc. M. '35), Asst. Prof., Civ. Eng., Kansas State Coll., Manhattan, Kans.

Pagels, George, Jr. (Jun. '34), Research Graduate Asst., Experiment Station, Iowa State Coll. (Res., 2107 Country Club Boulevard), Ames, Iowa.

Park, Archibald Gavin (Assoc. M., '34), Res. Engr., Public Works Dept., Balclutha, New Zealand.

Peters, George Hugo (Assoc. M. '34), Asst. Engr., Nassau County Engr., Mineola (Res., 280 North Columbus Ave., Freeport), N.Y.

Seeman, Lyle Edward (Jun. '34), Lieut., Corps of Engrs., U.S.A., Officer in Chg., Hydrographic Office, Nicaragua Canal Survey, Managua, Nicaragua; Care, State Dept., Washington, D.C.

Stevenot, Edward Waldo (Jun. '34), 1004 Park St., Santa Paula, Calif.

Stubler, Andrew James (Jun. '34), Catenary Foreman, P.R.R., Newark, N.J. (Res., 433 Seventh St., Brooklyn, N.Y.)

Watson, Ralph Arthur (Assoc. M. '34), Engr., Allison Steel Mfg. Co., Box 1090, Phoenix, Ariz.

Welton, Kenneth Earl (Jun. '34), 932 North Ave., Waukegan, Ill.

Woods, Kenneth Brady (Jun. '34), State Highway Testing Laboratory, Ohio State Univ. (Res., 209 West Norwich Ave.), Columbus, Ohio.

Woodward, Austin Clair (Jun. '34), Route 1, Kensington, Ohio.

Membership Transfers

Bornefeld, Charles Fowler (Jun. '10; Assoc. M. '17; M. '35), Cons. Engr., 1010 North Charles St., Baltimore, Md.

Carmichael, David Watson (Jun. '27; Assoc. M. '35), Res. Engr., James C. Harding, Mount Kisco, N.Y.

Chipman, Paul (Assoc. M. '07; M. '35), Office Engr., P. M. Ry., Gen. Motors Bldg., Detroit (Res., 82 Monterey Ave., Highland Park), Mich.

Cook, John Orth (Assoc. M. '27; M. '35), Project Engr., Allegheny County Work Div., State Emergency Relief Board, 544 Oliver Bldg. (Res., 544 Rossmore Ave., South Hills Branch), Pittsburgh, Pa.

De Arozena, Joe (Assoc. M. '29; M. '35), Res. Engr., State Highway Dept., Box 556, Phoenix, Ariz.

Diaz Segura, Miguel Antonio (Jun. '29; Assoc. M. '32), Carrera 3^a, No. 15–24, Bogota, Colombia.

TOTAL MEMBERSHIP AS OF FEBRUARY 9, 1935	
Members	5,685
Associate Members	6,077
Corporate Members	11,760
Honorary Members	18
Juniors	3,036
Affiliates	98
Fellows	3
Total	14,915

Granger, Armour Townsend (Assoc. M. '25; M. '35), Asst. Engr., Ash-Howard-Needles & Tammen, 111 Eighth Ave., Room 713, New York, N.Y.

Hartzog, Justin Richardson (Assoc. M. '30; M. '35), Associate of John Nolen, 406 Abbot Bldg., Harvard Sq., Cambridge, Mass.

Heyman, William (Jun. '11; Assoc. M. '13; M. '35), Pres.-Works Mgr., Heyman & Goodman Co. (Res., 211 Central Park West), New York, N.Y.

Hollister, Solomon Cady (Assoc. M. '19; M. '35), Director, School of Civ. Eng., Cornell Univ., Ithaca, N.Y.

Irwin, Luther Wesley (Jun. '30; Assoc. M. '34), Junior Engr., Met. Water Dist. of Southern California (Res., 3922 West 59th Pl.), Los Angeles, Calif.

Kelsey, James Robert (Assoc. M. '30; M. '34), Asst. Engr. of Design, San Francisco–Oakland Bay Bridge, 500 Sansome St., San Francisco, Calif.

Kerekes, Frank (Jun. '21; Assoc. M. '25; M. '35), Prof., Structural Eng., Iowa State Coll., Ames, Iowa.

Klein, Alexander (Jun. '30; Assoc. M. '34), Asst. Research Engr., Eng. Materials Laboratory, Univ. of California, Berkeley, Calif.

Loewus, Julian Simeon (Jun. '26; Assoc. M. '35), Senior Eng. Draftsman, U. S. Navy Yard, Washington, D.C. (Res., 2905 North Charles St., Baltimore, Md.)

Louchheim, William Sandel (Jun. '26; Assoc. M. '35), Vice-Pres., Keystone State Corporation, 1321 Arch St., Philadelphia, Pa.

Meadowcroft, Allan James (Jun. '26; Assoc. M. '34), Instr. of Eng., Canal Zone Junior Coll., Box 288, Balboa, Canal Zone.

Patterson, Donald (Jun. '23; Assoc. M. '29; M., '35), Dist. Bridge Engr., State Dept. of Highways, Box 1431, Uniontown, Pa.

Pollock, James Randal (Assoc. M. '22; M. '35), Director of Public Works and Utilities (Res., 211 West 8th St.), Flint, Mich.

Schegolkov, Victor K. (Jun. '29; Assoc. M. '35), Structural Draftsman, Isaacson Iron Works (Res., 4217 Second Ave., N.E.), Seattle, Wash.

Stephens, Richard, Jr. (Jun. '26; Assoc. M. '34), Asst. Engr., Met. Water Dist. of Southern California, Box A, Banning, Calif.

Volk, Kenneth Quinton (Assoc. M. '21; M. '34), Res. Engr., Met. Water Dist. of Southern California (Res., 176 North Highland Ave.), Los Angeles, Calif.

White, Howard Leslie (Jun. '32; Assoc. M. '34), Instr., Civ. Eng. Dept., Rose Polytechnic Inst., Terre Haute, Ind.

Reinstatements

Bennett, Manche Owen, M., reinstated Jan. 21, 1935.

Ciampa, Felix Anthony, Assoc. M., reinstated Jan. 15, 1934.

Clark, Charles Homer, M., reinstated Jan. 18, 1935. (The previous report of Mr. Clark's death was in error.)

Cochran, Herbert Ray, Assoc. M., reinstated Jan. 21, 1935.

Crute, Stanley, Assoc. M., reinstated Jan. 9, 1935.

De Line, Ralph Arthur, M., reinstated Jan. 18, 1935.

Derby, Elles Mayo, Assoc. M., reinstated Jan. 28, 1935.

Egbert, Donald Carlyle, Jun., reinstated Jan. 21, 1935.

Jasper, Edward Henry, Jun., reinstated Jan. 9, 1935.

JOHNSON, PHILIP ELLSWORTH, Assoc. M., reinstated Jan. 30, 1935.

UNGRICH, MARTIN JACOB, Assoc. M., reinstated Jan. 17, 1935.

RESIGNATIONS

ANDREWS, ALFRED STOKES, Assoc. M., resigned Jan. 10, 1935.

ASPLUNDH, EDWIN THEODORE, Assoc. M., resigned Jan. 7, 1935.

BOOKER, WARREN H., Assoc. M., resigned Jan. 14, 1935.

CRUTCHER, THOMAS BABER, JR., Jun., resigned Jan. 28, 1935.

DANZER, JOHN ROBERT, Jun., resigned Jan. 14, 1935.

DUYM, WILLIAM ANTHONY, Jun., resigned Jan. 10, 1935.

EVANS, JOHN EDWARD, Assoc. M., resigned Jan. 11, 1935.

FRIEDMAN, THEODORE WILLIAM, Jun., resigned Jan. 21, 1935.

GALLOWAY, CLARAN FRANKLIN, Assoc. M., resigned Jan. 10, 1935.

GOETHALS, GEORGE RODMAN, M., resigned Jan. 31, 1935.

GOSTANIAN, GOSTAN KAZAR, Jun., resigned Jan. 31, 1935.

HAND, WILLIAM ESSEX, Jun., resigned Jan. 10, 1935.

HERSHMAN, CHARLES LEONARD, Assoc. M., resigned Jan. 28, 1935.

HIGGINS, CHARLES HOUCHIN, M., resigned Feb. 2, 1935.

HURTGEN, HAROLD RAY, Jun., resigned Jan. 10, 1935.

ISAACSON, GEORGE HAROLD, Jun., resigned Jan. 22, 1935.

JOHNSON, NATHAN CLARKE, Assoc. M., resigned Jan. 14, 1935.

JONES, JOHN EDGAR, Jun., resigned Jan. 18, 1935.

MACKIE, THADDEUS HINSHAW, Jun., resigned Jan. 10, 1935.

MADELEY, JAMES WELBY, M., resigned Jan. 7, 1935.

MARTHENS, JOHN COWLEY, Jun., resigned Jan. 10, 1935.

MORGAN, AUSTIN, Jun., resigned Jan. 10, 1935.

OKAZAKI, BUNKICHI, M., resigned Jan. 28, 1935.

PARSONS, FRANCIS WAYLAND, Assoc. M., resigned Dec. 31, 1934.

RICHARDS, WALTER ALAN, M., resigned Jan. 10, 1935.

SEABRIGHT, RALPH WILLIAM, Jun., resigned Jan. 10, 1935.

SEELEY, DOUGLAS CHARLES, Jun., resigned Jan. 14, 1935.

SNYDER, LAWRENCE KING, Jun., resigned Jan. 21, 1935.

THOMPSON, TAZEWELL FRANKLIN, Jun., resigned Jan. 14, 1935.

WILLOUGHBY, ROBERT A., Jun., resigned Jan. 22, 1935.

WRAY, THEODORE STRONG, Assoc. M., resigned Jan. 14, 1935.

DEATHS

AMES, GEORGE MARSHALL. Elected Assoc. M., June 7, 1899; died Jan. 16, 1935.

BOLLER, ALFRED PANCOAST. Elected Jun., Oct. 2, 1894; Assoc. M., May 3, 1899; died Jan. 14, 1935.

BOUILLON, ALFRED VICTOR. Elected M., April 2, 1913; died Jan. 14, 1935.

FERGUSON, HARRY FOSTER. Elected Jun., June 23, 1916; Assoc. M., Oct. 9, 1917; died Jan. 16, 1935.

GARDNER, HARRY CARTER. Elected Jun., July 1, 1909; Assoc. M., Nov. 12, 1913; M., June 12, 1917; died Jan. 23, 1935.

HARTRIDGE, ALFRED LAMAR. Elected M., Mar. 13, 1917; died Jan. 23, 1935.

HODGMAN, BURT BRADLEY. Elected M., Nov. 25, 1919; died Jan. 20, 1935.

HOSMER, GEORGE LEONARD. Elected M., April 20, 1925; died Jan. 10, 1935.

JOHNSTON, GUY ROBERT. Elected Assoc. M., July 11, 1921; M., April 23, 1928; died Jan. 27, 1935.

KIDDLE, ALFRED WATTS. Elected Fellow, Am. Soc. C.E., Oct. 3, 1893; died Jan. 8, 1935.

MCLEAN, ARCHIBALD. Elected M., May 6, 1903; died Jan. 12, 1935.

MAINE, HERBERT AUGUSTA. Elected M., Aug. 4, 1924; died Nov. 25, 1934.

MYERS, EDMUND TROWBRIDGE DANA, JR. Elected Jun., May 2, 1888; M., June 7, 1899; died Oct. 27, 1934.

PARSONS, HARRY DE BERKELEY. Elected M., Feb. 3, 1897; died Jan. 26, 1935.

PHILLIPS, AUGUSTUS LYON. Elected M., June 23, 1916; died Jan. 31, 1935.

POTTER, WILLIAM BANCROFT. Elected M., March 2, 1904; died Jan. 15, 1934.

RITCHIE, JAMES. Elected M., Nov. 5, 1890; died Nov. 15, 1934.

STUART, FRANCIS LEE. Elected M., May 3, 1899; died Jan. 15, 1935.

TOLL, ASAHEL CLARK. Elected Jun., Mar. 5, 1907; Assoc. M., Oct. 29, 1912; date of death unknown.

TOMLINSON, SAM. Elected M., April 6, 1892; died Jan. 23, 1935.

WILLIS, PAUL. Elected M., Oct. 2, 1901; died Jan. 30, 1935.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

March 1, 1935 NUMBER 3

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

FOR ADMISSION

ARGERSINGER, EDWARD MILLER, Seattle, Wash. (Age 22.) Refers to I. L. Collier, G. E. Hawthorn, C. C. More, R. G. Tyler.

ASPLAND, GEORGE HENRY, Brooklyn, N.Y. (Age 44.) Res. Engr. Inspector, PWA, Washington, D.C. Refers to W. J. Backes, H. G. Balcom, M. E. Gilmore, H. W. Lesh, E. M. Plump.

BELL, SEATON JUNE, Houston, Tex. (Age 33.) Refinery Engr., American Petroleum Co. Refers to E. C. H. Bantel, J. H. Bringhurst, S. P. Finch, J. A. Focht, M. C. Nichols, T. U. Taylor, J. B. Townsend.

BOWMASTER, WYLIE ALBERT, Knoxville, Tenn. (Age 26.) With Tennessee Valley Authority, on rainfall and flood studies. Refers to C. M. Cade, E. J. Rutter, G. R. Scott.

BROOKS, JOHN HAPGOOD, JR., Worcester, Mass. (Age 57.) Supt. of Sewers, Sewer Dept. Refers to C. M. Allen, W. L. Darling, H. P. Eddy, A. W. French, C. B. Hardy, A. B. Holmstrom, J. W. Howe, A. J. Knight, F. T. Oakley, F. O. Price, P. P. Spaulding, J. A. Tosi, L. W. West, J. W. Williams.

BALDWIN, MATTHEW RAYMOND, New York City. (Age 28.) With Park Dept., New York City. Refers to J. A. Guttridge, A. E. Hilliard, C. G. Moerner, Jr., J. D. Moore, H. H. Pitcairn, J. Wilmot.

BRUCE, JOHN FREDERICK, Lincoln, Nebr. (Age 26.) Refers to J. A. Bruce, R. M. Green, E. V. Grupe, Jr., H. J. Kesner, C. E. Mickey, C. C. Nicholls.

BURG, PHARO COLLINS, Ann Arbor, Mich. (Age 23.) Instrumentman, U. S. Coast and Geodetic Survey. Refers to A. C. Copland, D. Ferguson, L. M. Gram, H. W. King, L. C. Maugh, V. B. W. Poulsen.

BYRNE, THOMAS GORMAN, Philadelphia, Pa. (Age 23.) Refers to C. M. Spofford, J. B. Wilbur.

CAPONE, DOMENIC, East Boston, Mass. (Age 25.) Computer, Public Works Dept., Boston, Mass. Refers to H. P. Burden, R. W. Lefavour.

CHOCOLE, JOSEPH FRANK, Chicago, Ill. (Age 24.) Constr. Dept., Wilson & Co. Refers to N. D. Morgan, C. E. Palmer.

CONRAD, FREDERICK XAVIER, Port Jervis, N.Y. (Age 35.) City Engr. Refers to S. Baker, H. E. Breed, T. C. Desmond, C. A. Gridley, W. A. Hardenbergh, A. V. D. Wallace, Jr., A. M. Wyman.

DETWEILER, JOHN CONNETT, Omaha, Nebr. (Age 35.) Constr. Engr., Metropolitan Utilities Dist. Refers to W. H. Campen, R. L. Cochran, G. P. Dorsey, R. E. Edgecomb, D. L. Erickson, R. H. Findley, T. A. Leisen, B. Manchester.

DE VRIES, KARL, Bethlehem, Pa. (Age 40.) Designer, Bethlehem Steel Co., and McClintic-Marshall Corporation. Refers to E. F. Ball, S. W. Bradshaw, E. L. Durkee, J. Jones, C. H. Mercer, P. B. Tartt.

DOUGLAS MALCOLM STEWART, Cleveland, Ohio. (Age 36.) Asst. Prof. of Civ. Eng., Case School of Applied Science. Refers to D. W. Mead, F. H. Neff, G. B. Sowers, E. H. Sprague, F. E. Turneaure, W. J. Watson.

FLEBUS, CARLO GIUSEPPE, Brooklyn, N.Y. (Age 36.) Refers to R. S. DuBois, H. W. Hudson, S. Johannesson, F. A. Rossell, M. P. Van Buren.

FOSTER, JAMES PATRICK, Flushing, N.Y. (Age 25.) Computer, U. S. Coast and Geodetic Survey, New York City. Refers to E. W. Firth, A. Levin, J. F. Perrine, F. B. Tucker, B. Weiss.

GANNETT, FARLEY, Harrisburg, Pa. (Age 54.) Gannett, Seelye & Fleming Corporation. Refers to W. H. Corddry, W. W. De Berard, G. G. Dixon, P. Hansen, T. E. Seelye, F. H. Snow.

GANO, WARDEN WARREN, Seattle, Wash. (Age 21.) Refers to I. L. Collier, C. W. Harris, G. E. Hawthorn, C. C. More, R. G. Tyler.

GIBONEY, DAVID FRANCIS, Serres, Greece. (Age 45.) Office Engr., John Monks & Sons, Ulen & Co. Refers to M. A. Butler, C. J. Carroll, C. E. Cate, H. M. Chadwick, C. S. Heidel, H. N. Jones, M. R. Keefe, W. E. Swift.

GRAMATKY, FERDINAND GUNNER, Vidal, Cal. (Age 28.) Engr., Jahn and Bressi Constr. Co., Inc., Los Angeles. Refers to N. F. Jahn, R. R. Martel, W. W. Michael, R. P. Miller A. G. Roach, F. Thomas.

HALL, DAVID BREWER, Albany, N.Y. (Age 30.) Asst. Engr., New York State Dept. of Public Works. Refers to W. Bertwell, J. P. Exum, A. T. Granger, A. Karolak, R. E. Peck, J. J. Schnebelen.

HAUGHWOUT, FREDERICK EUGENE, Buffalo, N.Y. (Age 27.) Asst. Res. Engr. Inspector, PWA. Refers to O. L. Brodie, G. W. Knight, T. B. Oakley, V. H. Reichelt, R. W. Wood.

HOUSNER, GEORGE WILLIAM, Altadena, Cal. (Age 24.) Refers to F. J. Converse, H. W. King, R. R. Martel, F. Thomas, C. O. Wisler.

HOWELL, GILBERT PIERRE TRUXTON, Albuquerque, N.Mex. (Age 37.) Asst. to Chf. Engr., U. S. Soil Erosion Service, Navajo Project. Refers to H. P. Bunger, J. H. Dorroh, C. H. Howell, H. C. Neuffer, W. B. Ream, R. H. A. Rupkey.

JAMES, RUSSELL WALKER, Denver, Colo. (Age 39.) Associate Highway Bridge Engr., Bureau of Public Roads, U. S. Dept. of Agriculture. Refers to J. M. Angle, P. S. Bailey, L. F. Copeland, R. S. DuBois, J. V. McNary, J. E. Maloney, O. T. Reedy.

KEMP, WILBUR ALTON, Columbus, Ohio. (Age 34.) Asst. Res. Engr. Inspector on intercepting sewers. Refers to O. Bonney, R. C. Chaney, W. L. Glazier, D. G. Hatmaker, H. H. Kranz, L. LaRue, R. R. Pyne.

KIRKPATRICK, WILLIAM, Cross Roads, Jamaica, B. W. I. (Age 31.) Supt., Filter Plants and Water Distribution, Water and Sewerage Board, Kingston. Refers to E. N. Bancroft, W. P. Beckwith, H. J. Dignum, E. H. Magoon, E. N. Mais, A. A. Simms.

MCCLURE, THOMAS MERO, Santa Fe, N.Mex. (Age 39.) New Mexico State Engr. Refers to E. L. Barrows, J. H. Bliss, P. S. Fox, F. G. Healy, B. Johnson, G. D. Macy, H. C. Neuffer.

MCCORKLE, ADOLPHUS JAMES, Pensacola, Fla. (Age 32.) Draftsman, U. S. Coast and Geodetic Survey, Air Photo Compilation Unit No. 24. Refers to M. M. Bernard, C. M. Kerr, T. E. Leahy, F. A. Muth, O. K. Olsen, B. W. Pegues.

MARTIN, EDGAR FLOYD, Montclair, N.J. (Age 46.) Town Engr. Refers to L. J. Bevan, S. C. Hamilton, Jr., G. W. Harris, H. W. Heilmann, F. D. Leffingwell.

MELLICK, LLOYD VOLNEY, LaCrosse, Kans. (Age 46.) Asst. Supervisor of Work Program, Kansas ERC, Res. Engr., Lake Project, Rush County. Refers to L. E. Conrad, W. C. McNown, I. Rogers, H. A. Rowland, L. R. Tillotson.

MORTON, WILLIAM, Stevenson, Wash. (Age 28.) Levelman with U. S. Engrs., Bonneville, Ore. Refers to H. G. Gerdes, G. E. Goodwin, L. Griswold, J. H. Lewis, H. A. Rands.

OFFICER, JOHN DEE, Los Lunas, N.Mex. (Age 23.) Sanitarian for Valencia County, N. Mex. Refers to W. W. Baker, J. H. Dorroh, C. H. Howell, H. C. Neuffer, L. B. Reynolds, F. C. Scobey.

OFFICER, ROBERT MAYFIELD, Raton, N.Mex. (Age 25.) Sanitarian, Santa Fe County, N. Mex. (U. S. Public Health Service.) Refers to E. L. Barrows, J. H. Bliss, H. J. Brunnier, J. H. Dorroh, G. D. Macy, A. S. Niles, L. B. Reynolds, J. B. Wells.

PAPPIN, GORDON FRANCIS, Great Falls, Mont. (Age 25.) City Engr., Inspector and Supt. of Water Works. Refers to A. P. Learned, R. H. Willcomb.

PEURIFOY, ROBERT LEROY, Kingsville, Tex. (Age 32.) Prof. of Civ. Eng., and Director of School of Eng., Texas Coll. of Arts and Industries; also City Engr. Refers to E. C. H. Bantel, R. F. Dawson, J. A. Focht, J. J. Richey, T. U. Taylor.

QUICK, PHILLIP RUSSELL, Berkeley, Cal. (Age 33.) Civ. Engr. with W. A. Bechtel Co., Bechtel, Kaiser, Warren Co., Henry J. Kaiser Co., and Bridge Builders, Inc. Refers to E. H. Connor, E. L. Cope, C. Derleth, Jr., B. A. Etcheverry, B. Jameyson, C. B. Jansen, J. Shaw.

ROBEY, WALTER EARL, Chicago, Ill. (Age 31.) Bridge Designer, Atchison, Topeka and Santa Fe Ry. Refers to F. W. Dencer, C. Derleth, Jr., G. W. Harris, C. H. Sandberg, R. A. Van Ness, C. E. Webb.

RUGE, ARTHUR CLAUDE, Cambridge, Mass. (Age 29.) Research Associate in Seismology, Dept. of Civ. and San. Eng., Massachusetts Inst. of Technology. Refers to J. B. Babcock, 3d, C. B. Breed, O. Dunkel, W. M. Fife, F. M. McCullough, C. M. Spofford.

SEIM, MAYNARD CLIFFORD, Chicago, Ill. (Age 24.) Inspector, U. S. Engr. Dept. Refers to C. R. Andrew, J. G. Bennett.

SHILSTONE, HERBERT MAXWELL, JR., Houston, Tex. (Age 25.) Bldg. Materials Inspector and Testing Engr., Shilstone Testing Laboratory. Refers to F. N. Billingsley, D. Derickson, W. B. Gregory, C. R. Haile, J. M. Howe, J. Klorer, S. Seiferth.

SMITH, PAT BENTON, Pittsburg, Kans. (Age 32.) Res. Engr. Inspector, PWA, Kansas. Refers to E. Boyce, B. Boyle, L. E. Curfman, R. J. Paulette, R. E. Reed, M. A. Wilson.

SPELLMAN, CLEMENS EUGENE, Lincoln, Nebr. (Age 28.) Bridge Designer, Bureau of Roads and Irrigation, Nebraska Dept. of Public Works. Refers to W. Grant, P. F. Keim, H. J. Kesner, J. G. Mason, A. L. Ogle.

SVOBODA, GEORGE WESTBROOK, Berwyn, Ill. (Age 22.) Refers to J. J. Doland, E. E. King

TAYLOR, EDWARD HOLBROOK, Vicksburg, Miss. (Age 22.) Refers to B. A. Etcheverry, S. T. Harding, M. P. O'Brien.

TCHERNOWITZ, JACK KALMAN, New York City. (Age 26.) Refers to J. S. Crandell, W. C. Huntington, W. A. Oliver.

TING, SIEH-HOU, Wu-Chang, Hupeh, China. (Age 29.) Prof. of Civ. Eng., National Wu-Han Univ. Refers to T. King, S-T. Li, Y-F. P. Sun, O. J. Todd, F-Y. Tsai.

TODD, NORMAN HAGEN, Denver, Colo. (Age 34.) Civ. Engr., Colorado State Highway Dept. Refers to P. S. Bailey, E. H. Dauchy, J. E. Maloney, F. M. Okey, O. T. Reedy, W. W. Schuyler, B. F. Vandervoort.

VOSS, HERMAN, New York City. (Age 37.) Designer and Checker with Gibbs & Hill, Cons. Engrs. Refers to W. J. Ash, J. Feld, F. C. Lowy, F. W. Ockert, R. Smillie, D. B. Steinman, R. H. Vanderbrook, E. Welle.

WARD, SAMUEL, Cleveland Heights, Ohio. (Age 45.) Prof. of Civ. Eng., and Head of Civ. Eng. Dept., Fenn Coll., Cleveland. Refers to A. F. Blaser, A. P. Bursley, C. N. Conner, J. M. Heffelfinger, Jr., R. Hoffmann, G. B. Sowers.

WHITE, ALFRED EVERETT, Keene, N.H. (Age 46.) Div. Engr., New Hampshire State Highway Dept. Refers to J. W. Childs, H. B. Drowne, F. E. Everett, L. F. Johnson, L. C. Marshall.

WIGGINS, THOMAS EDWARD, Norman, Okla. (Age 41.) Engr., Works Div., FERA, Garvin County, Okla.; Cons. Engr. on design work. Refers to V. H. Cochrane, F. Herrmann, D. H. Jones, R. V. Lindsey, A. Montgomery, D. Witten, N. E. Wolfard.

WILSON, NEIL HAROLD, Balboa, Canal Zone. (Age 31.) Asst. Engr., Madden Dam Div., The Panama Canal. Refers to H. G. Arango, J. E. Deignan, W. B. Godfrey, R. C. Jones, R. L. Klotz, E. S. Randolph.

ZUZZOLO, FRANK DOMINICK, Mt. Vernon, N.Y. (Age 25.) Refers to D. M. Burmister, J. K. Finch.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

ADAMS, CLAUDE HARDY, Assoc. M., Glens Falls, N.Y. (Elected Jan. 17, 1927.) (Age 47.) Vice-Pres. and Gen. Mgr., Adams Bros. Constr. Corporation. Refers to C. L. Bannister, R. G. Finch, L. S. Hulburd, J. H. Sturdevant, E. Talbot, E. W. Wendell.

ANDERSON, GEORGE HAROLD, Assoc. M., Herrin, Ill. (Elected Nov. 12, 1928.) (Age 36.) Civ. & Highway Engr.; City Engr., Herrin, Ill.; Superv. Engr., Franklin, Jefferson and Union Counties, Illinois. Refers to G. H. Baker, G. F. Burch, P. E. Green, C. F. Hamilton, A. H. Hunter, C. A. Petry, G. A. Quinlan, F. T. Sheets, R. W. Wallace.

BURKE, MICHAEL JOSEPH, Assoc. M., Chicago, Ill. (Elected Junior, Jan. 16, 1919; Assoc. M., Jan. 17, 1921.) (Age 41.) Engr., Structural Design, Outer-Drive Improvement, Chicago. Refers to R. A. Black, F. W. Dencer, G. T. Donoghue, A. Engh, C. J. Kennedy, C. E. Paine, C. A. Paquette, A. Skrede, A. M. Turner, H. E. Young.

COMBS, LEWIS BARTON, Assoc. M., Great Lakes, Ill. (Elected June 6, 1927.) (Age 39.) Lieut. Commander, C.E.C., U. S. Navy; Public Works Officer, Naval Training Station. Refers to R. B. Bakenhus, C. H. Cotter, G. A. McKay, B. Moreell, A. L. Parsons, C. D. Thurber, W. C. Voss, D. C. Webb.

COX, MOSES EUGENE, Assoc. M., Decatur, Ga. (Elected Oct. 14, 1929.) (Age 40.) Consulting work, Atlanta, Ga. Refers to R. P. Black, F. H. McDonald, S. B. Slack, C. A. Smith, F. C. Snow, C. M. Strahan, C. C. Whitaker, S. R. Young.

DYER, HARRY BUTTORFF, Assoc. M., Nashville, Tenn. (Elected Junior, Nov. 21, 1921; Assoc. M., Dec. 14, 1925.) (Age 35.) Vice-Pres., Nashville Bridge Co. Refers to L. C. Anderson, C. N. Bass, E. W. Bauman, A. J. Dyer, F. J. Lewis, H. McDonald, E. B. Wilkinson, D. H. Wood.

EAST, LEWIS RONALD, Assoc. M., Blackburn, Victoria, Australia. (Elected Aug. 29, 1927.) (Age 35.) Commr., State Rivers and Water Supply Comm., Melbourne, Victoria, Australia. Refers to J. T. N. Anderson, H. Conradi, A. L. Galbraith, G. Higgins, C. W. N. Sexton, H. M. Sherrard, I. M. Sutherland.

PAGE, AUSTIN ELMER, Assoc. M., Concord, N.H. (Elected July 14, 1930.) (Age 44.) Dist. Engr., Lane Constr. Corporation, Meriden, Conn. Refers to J. W. Childs, H. B. Drowne, F. E. Everett, E. D. Parker, I. W. Patterson.

VEATCH, FRANCIS MONTGOMERY, Assoc. M., Kansas City, Mo. (Elected Junior, Jan. 6, 1915; Assoc. M., April 14, 1919.) (Age 44.) With Black & Veatch, Cons. Engrs. Refers to E. B. Black, E. Boyce, W. Donaldson, A. H. Douglass, D. L. Erickson, D. E. Kepner, E. K. Nelson.

FROM THE GRADE OF JUNIOR

ALLEN, EDWARD RUSSELL, Jun., Towson, Md. (Elected Nov. 11, 1929.) (Age 29.) Chf. Draftsman, The J. E. Greiner Co., Baltimore, Md. Refers to H. H. Allen, W. T. Ballard, J. E. Greiner, A. N. Johnson, J. K. Knoerle, O. H. Schroedl, W. Willoughby.

ALPERIN, MAX, Jun., Brooklyn, N.Y. (Elected April 15, 1929.) (Age 32.) Asst. Engr., Dept. of Finance, City of New York; Tech. Advisor and Consultant to Mohegan Colony, Inc., Westchester County. Refers to B. J. Ahearn, R. W. Armstrong, N. Epstein, A. E. Hilliard, A. Lyle, J. D. Schwartz.

DORITY, ALEX OUSLEY, Jun., Pensacola, Fla. (Elected Feb. 24, 1931.) (Age 32.) With U. S. Coast and Geodetic Survey. Refers to R. J. Bear, J. M. Belknap, A. M. Bouillon, J. F. Charlton, W. N. Downey, W. M. Hall, P. Jones, P. Moller, T. H. Niermann, R. Ritter, G. P. Stowitts, J. B. Sullivan.

HOHLWEG, WILLIAM AUGUST, Jun., Grantsville, Md. (Elected May 19, 1924.) (Age 32.) Engr. Foreman, CCC Camp, near Grantsville. Refers to D. Atkins, Jr., F. A. Barnes, C. J. Carroll, F. J. Clark, A. T. Ewell, F. M. Kipp, Jr., G. J. Requardt, V. B. Siems, P. A. Welty.

KERR, GEORGE WATSON, Jun., Newark, Ohio. (Elected Oct. 26, 1931.) (Age 32.) Asst. Materials Engr., Ohio Div. of Highways. Refers to W. W. Anderson, B. H. Frasch, R. E. Hamilton, R. R. Litehiser, W. W. Purdy.

LABOON, FRAZIER PICKENS, Jun., Washington, D.C. (Elected Oct. 1, 1926.) (Age 32.) Asst. Highway Engr., Bureau of Public Roads. Refers to G. R. Clemens, C. W. Cochran, A. F. Gordon, B. P. Harrison, S. M. Rudder, C. M. Spofford.

MIDDLEBROOKS, THOMAS ALWYN, Jun., Ft. Peck, Mont. (Elected Nov. 23, 1931.) (Age 31.) Associate Engr., U. S. Engrs. Refers to O. G. Baxter, G. R. Clemens, T. B. Larkin, J. C. H. Lee, L. F. Reynolds, K. R. Young.

MILAN, ANTHONY GEORGE, Jun., West Chester, Pa. (Elected April 23, 1928.) (Age 32.) Res. Engr., WD, SERB, Harrisburg, Pa. Refers to W. S. L. Cleverdon, W. E. R. Irwin, J. T. Kiernan, E. C. Macy, J. W. May, J. L. Orr, G. Schobinger, C. T. Schwarze, F. W. Schwiers, Jr., C. H. Snow, D. B. Zentmyer.

MORSE, ROY WINCHESTER, Jun., Seattle, Wash. (Elected Oct. 1, 1928.) (Age 28.) Asst. Engr., W. C. Morse Co. Refers to N. A. Carle, H. W. McCurdy, R. E. Miller, W. C. Morse, C. D. Pollock.

OHLSEN, WALTER CLAUSE, Jun., Ames, Iowa. (Elected March 11, 1929.) (Age 32.) Structural Designer, Iowa State Highway Comm. Refers to W. N. Adams, T. R. Agg, R. A. Caughey, H. J. Hansen, F. Kerekes, S. H. Smith.

ONDRUS, THOMAS, Jun., Berwyn, Ill. (Elected Oct. 30, 1933.) (Age 32.) Rodman, Chicago, Milwaukee, St. Paul & Pacific R. R. Co. Refers to H. E. Babbitt, D. C. Fenstermaker, W. C. Huntington, C. T. Jackson, G. W. Pickels, W. H. Vosburg.

ORR, HAROLD RIPLEY, Jun., Denver, Colo. (Elected Oct. 10, 1927.) (Age 32.) Asst. Engr., U. S. Bureau of Reclamation. Refers to O. N. Floyd, J. J. Hammond, J. L. Lochridge, L. G. Puls, A. B. Reeves, T. C. Shuler, G. S. Thompson.

RICHARDS, GUY, Jun., New Galloway, Kirkcudbrightshire, Scotland. (Elected Nov. 10, 1930.) (Age 28.) Asst. Res. Engr., Sir Alexander Gibb & Partners, Cons. Engrs. Refers to C. B. Breed, R. Freeman, A. Gibb, G. E. Russell, B. W. Tawse.

STEENBERGEN, WILLIAM ARTHUR, Jun., Tucson, Ariz. (Elected Oct. 14, 1930.) (Age 32.) Land Planning Consultant, National Resources Board. Refers to E. S. Borgquist, J. A. Fraps, F. C. Kelton, R. H. A. Rupkey, H. C. Schwalen, G. E. P. Smith.

TIO Y NAZARIO DE FIGUEROA, AURELIO, Jun., San German, Puerto Rico. (Elected March 11, 1929.) (Age 27.) Contract work for Dept. of Interior, Puerto Rico. Refers to J. M. Bertran, M. Font, F. Fortuno-Selles, E. Ortega-Rosado, F. Pons, A. S. Romero, E. Totti y Torres.

WILLIAMS, GEORGE DAVIS, Jun., Beaumont, Tex. (Elected Jan. 13, 1930.) (Age 31.) Asst. Res. Engr., State Highway Dept., Div. 20. Refers to R. C. Black, G. A. Bracher, W. O. Jones, J. T. L. McNew, J. J. Richey.

WINTER, JOHN EVERETT, Jun., San Francisco, Cal. (Elected Jan. 25, 1932.) (Age 32.) Engr., Transbay Constr. Co., San Francisco-Oakland Bay Bridge. Refers to A. H. Ayers, F. T. Crowe, A. Donaldson, C. P. Dunn, J. R. Guptill, H. B. Luther, R. W. Renn.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 85 of the 1934 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when the reply should be sent to the office designated.

CONSTRUCTION

CONSTRUCTION AND CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; Wisconsin state license; university graduate; 12 years experience on road, bridges, walls, etc.; cost reports, surveying, office work, subdivision, supervision, and inspection. Salary or location no object if there is possibility of advancement and some degree of permanency. Available immediately. C-6632.

CONSTRUCTION ENGINEER; Jun. Am. Soc. C.E.; 32; married; B.S. in C.E., New York University; enrolled Alexander Hamilton Institute business course; 5 years experience as contractor's engineer on costs and construction, bridges, roads, bulkheads, and foundations; 4 years with telephone company, as engineer in charge, on 50 miles of conduit construction and 35 miles of conduit rearrangement. Desires responsible position with future. C-5622.

DESIGN

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 23 years experience; 2 degrees; design, surveying, and estimating for contractor; factories, railroads, housing, and real-estate development. A-2505.

EXECUTIVE

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 29; married; B.S. in C.E., Manhattan College, 1927; 2 years experience drafting on subway construction; 4 years experience as transitman and chief of party; 1 year experience on highway and bridge construction; desires position in any branch of civil engineering. Available immediately. D-3617.

GRADUATE CIVIL ENGINEERING; Assoc. M. Am. Soc. C.E.; registered in two states; 13 years experience; desirous of making connections; 4 years in supervision and construction of concrete highways and bridges; 5 years in charge of preliminary surveys and plans for municipal improvements; 4 years as construction engineer for large industrial plants—installation of equipment and preliminary operations. D-1100.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; college graduate; married; 15 years experience on triangulation, survey, railroad, railroad buildings, and construction; sewer, drainage, bridges, grade crossings; heavy foundations, caissons, and reinforced concrete piles. In charge of layout and inspection; contractor's and final estimate; design; artistic topographical, engineering, and mechanical draftsman; 2 weeks notice. D-3628.

CIVIL ENGINEER; M. Am. Soc. C.E.; 49; 27 years experience, specializing in investigation, design, inspection, and consultation on, and construction of large hydro-electric projects in this country and abroad. Desires responsible position with engineering or contracting organization, designing or constructing; can handle any phase of latter work, including plant layout, cofferdams, installation of machinery, etc. B-70.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate of Massachusetts Institute of Technology, 1908; 25 years experience on design of steel and concrete structures and as resident engineer on construction for iron and steel industry; thoroughly competent to direct design or to supervise construction in the field. Exceptional references. At present employed. B-5607.

CONSULTING AND CONSTRUCTING ENGINEER; M. Am. Soc. C.E.; for over 30 years has been going into Latin-American and Far-Eastern countries, opening them up, building water supplies, hydro-electrical installations, and power plants with railroad and harbor developments. Available immediately for countries in which there has been a recent change of government, to report on concessions and existing installations with their operation as well as to carry out new work. A-5380.

CONCRETE SPECIALIST; Assoc. M. Am. Soc. C.E.; 32; 10 years experience; capable of organizing and supervising concrete inspection, and concrete testing laboratory on large projects. Experience on special investigation and in making reports on concrete and the behavior of its constituents. Several papers and discussions published in technical periodicals. Excellent references. C-8022.

JUNIOR

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 22; single; B.S. in C.E., Newark College of Engi-